SCHOOL SCIENCE AND MATHEMATICS

VOL. XXV, NO. 6. JUNE, 1925 WHOLE NO. 215

INTERESTING RESULTS FROM BIRD-BANDING ACTIVITIES.

BY FRANK SMITH,

University of Illinois, Urbana, Ill.

There is abundant evidence in support of statements frequently made in recent years, intimating that bird banding has led to results of greater general interest to bird lovers than those now being gained from any other single source. Because of the recent increase in the number of workers actively engaged in bird banding, there is promise of results of still greater interest in the near future. Literally thousands of birds are now wearing the little aluminum bands which are being supplied by the Bureau of Biological Survey of Washington, D. C., and each bearing its own special number which furnishes the clue to the locality and date of banding, and to the person by whom the band was attached. The subsequent recapture of such birds has already positively proven that it is a common thing for birds of certain kinds that make annual migrations of hundreds or even thousands of miles to return to the same locality during successive summers, and sometimes use the same nesting sites, and even occasionally have the same mates as in previous summers. It has been shown that young birds may return in summer to their birthplaces for their summer homes. Data have been obtained showing the return of birds to the same winter homes and to the same localities while on successive migration journeys. Knowledge has also been gained concerning the age attained by certain individual birds. A Brown Thrasher that had been banded early in 1915 was recaptured in 1922, when it must have been at least about eight years old. Of importance also is the information obtained concerning the general routes followed by individual birds and the places of sojourn during their annual migrations.

Obviously it is essential for the maximum success in gaining these results that there shall be not only as many recaptures of

banded birds as possible, but also that the recoveries of bands from dead birds shall be as complete as possible. For such recoveries of bands from dead birds dependence is necessarily based quite largely on the cooperation of the general public. Such cooperation can be realized to the fullest extent only when this general public understands something of the significance of these bands, what to do with them when found, and of the desirability of examining all dead birds found in order to learn whether they had been banded. It is especially desirable that all teachers shall be informed of the nature and importance of this banding work and that they pass the information on to their pupils. Active cooperation of the newspapers in disseminating such information is especially desirable. It should be made clear that bands taken from dead birds are to be returned to the Biological Survey, Washington, D. C., together with statements giving the date when found, the locality, and the cause of death, if known. If living birds with bands are captured, they should be released without removing the bands, but the number should be carefully noted and statements giving the number, date and locality sent to the Biological Survey. Without information from some outside source the finder of such bands will, in many cases, not know what they are for, nor what to do with them. The bands in common use have on the exposed surface the number and the abbreviation: Biol. Surv. On the reverse side is the abbreviation: Wash., D. C. Unless the band is removed and both sides examined the finder will not learn where the band should be sent since, even if he knew the meaning of Biol. Surv., he might suppose it to refer to some state survey. Such removal of the band from a bird in an advanced stage of decomposition might not be made unless the finder understood the purpose of such bands.

I have been interested in an attempt to summarize the data contained in various published records which involve the return of birds to the same summer or winter homes in subsequent years. I wished to learn what different kinds of birds are found to do this; how many records are already available for such species; and also how widely distributed over North America are the localities in which records have been secured. Among the published record lists examined is a recent one by F. C. Lincoln of the U. S. Biological Survey covering the period from January 1, 1920 to June 30, 1923; another one which has appeared in six recent numbers of the Canadian Field Naturalist and includes

records involving Canadian territory; also the records published by S. P. Baldwin of Cleveland, Ohio, and W. I. Lyon of Waukegan, Illinois; and still other scattered data found in Wilson Bulletin, Auk, Bird-Lore, and elsewhere.

The great majority of the banding records of adult birds thus far obtained are from kinds of birds which have food habits, such that they are readily lured into traps provided with suitable food for bait; or those that have nesting habits such that the birds may be easily captured during nesting activities. From many well-known kinds of birds no banding records are available since the birds are not readily captured and hence few or no specimens have been banded.

I have found six records of Bluebirds that have been recaptured in the same localities in summers succeeding the ones in which they were banded. Three of these records are from three different localities in Massachusetts and the other three are from one locality near Cleveland, Ohio.

Records of the return of Robins to the same localities in summers following the ones in which they were banded are more numerous. Three such records have been obtained in Ontario and about 30 in the United States in localities distributed in 15 different states ranging from Massachusetts to Kansas.

Very few thrushes have been banded. A Hermit Thrush banded in Georgia in February, 1917 and retaken in the same locality in 1920 is the most interesting record. This of course implies a return to the same winter home or to the same locality on a migration route and not the same summer home.

A record of a Ruby-crowned Kinglet banded in March, 1923, in Georgia and recaptured in the same trap in January, 1924, also involves a return to the same winter home and is the only return record of Kinglets noticed by me. Their summer range is chiefly north of the United States.

House Wrens are among the best known of those making regular returns to same summer homes. We have one such record from Ontario and 26 records from localities in seven states ranging from New Jersey to Illinois. There is a record of the same two birds being mated in two consecutive seasons.

Brown Thrashers furnish 26 records of returns in subsequent years in nine localities ranging from New Jersey to Kansas and from Illinois to Georgia. Most of these records are from localities north of their ordinary winter range and hence have to do with individuals that migrated. In Georgia two banded mates of 1915 were again mates in 1916.

I find 21 records of the return of Catbirds to former summer homes in seven states ranging from New Jersey to Kansas. The winter distribution of the Catbird is given as Florida and farther south.

Return records of warblers are very scanty and limited chiefly to Myrtle, Palm, and Pine Warblers, returning to their winter homes. Myrtle Warbler records show several individuals returning after three years to the same locality and one specimen four years after first being banded.

Few specimens of Swallows are banded and records are scanty. One Bank Swallow banded in Alberta, Canada, in July, 1922, returned to the same station in July, 1923. They winter far south.

Tree Swallow return records are limited to three from Canada, two of these at Ottawa, Ontario, and a third one in Manitoba. This latter one banded May 27, 1923, returned to the same bird box on May 10, 1924. They winter far south.

One Barn Swallow record from Saskatchewan is of a bird banded in May, 1923 which was recaptured in June, 1924, and nested in the same building it had used the preceding year. They also winter far south.

The Fringillidae being seed eating birds are easily trapped and have been banded in large numbers and records of returns are correspondingly numerous, especially from a few species of sparrows.

A Rose-breasted Grosbeak banded in 1919 at Waukegan, Illinois, was retaken at the same place in 1920 and again in 1923. They winter in Central and South America.

A Towhee record is of a specimen taken two successive summers at a locality in Massachusetts.

Over 70 records are found of Song Sparrows that have returned to the same summer homes ranging from Ottawa, Ontario to Manitoba and in seven states including New Hampshire and Illinois.

17 records of Chipping Sparrows showing similar returns include Ontario and seven states from Maine to Michigan. Of especial interest is a record in the last number of Auk from Cohasset, Massachusetts of a banded pair of Chipping Sparrows that reared a brood in 1923 and returned to the same place in 1924 and reared two broods.

There are numerous records distributed over a considerable range of territory which show that specimens of Slate-colored

Juncos, White-throated Sparrows, and Tree Sparrows have returned to the same winter homes for one or more seasons.

Records of 35 Purple Finches show returns to the same summer homes in succeeding years. These records are from Massachusetts and Northern Michigan.

One record each from Massachusetts, Illinois, and Saskatchewan show specimens of Bronzed Grackles returning to the same summer homes.

Two records deal with two Cowbirds that returned to the same locality in Northern Illinois for a second summer.

Chimney Swift records are few in number, but very interesting. These birds are reported as wintering in Central America. A Kansas record shows that a specimen banded in 1922 returned to the same locality in 1923. The most surprising record is from Ohio of a bird banded in June, 1916 and retaken in the same chimney in June, 1917 and again in June, 1921. It was recaptured in the same locality in 1922 and 1923, but whether or not from the same chimney is not stated. Banded in 1916 when at least a year old it must have been eight years old anyway when taken in 1923.

The only record of the return of a Nighthawk to its summer home, of which I know, is one not yet published but soon to appear. These birds are frequently found rearing their young on the gravel roofs of buildings in cities. A well-known ornithologist of New England succeeded in banding a female nighthawk and young, at home on the roof of a high school building. The following summer the same female returned to the same roof and reared another family.

A Flicker record shows the presence of one specimen in Northern Ohio in the summer two years subsequent to the one in which it had been banded, and in the same locality. Another specimen banded in Northern Illinois was retaken while using the same nest hole that it had used the preceding summer when it was banded. A third record from Manitoba is similar, while a fourth one from Alberta is of a male which was banded in the summer of 1923 and returned in 1924 and was taken at the same nest hole and with the same mate as in the preceding summer.

Two northern records of Mourning Doves taken in the same localities in succeeding summers are from Ohio and Kansas.

A Florida Gallinule, which was banded in Ontario, was retaken at the same place the next summer.

There are great numbers of records based on bands recovered from dead birds that indicate something of the direction and distances travelled in the course of their migration activities. Nearly all of the records from water birds are of this kind.

RADIO CLUBS IN HIGH SCHOOL.

By Hallie Turner, A.M.
Albany, Wis.

One of the activities of which there is a growing need in high schools in the last few years is that of a radio club. It is not difficult to find in any high school, no matter how small, a group of students who are extremely interested in radio and who want to learn something about it. They have been experimenting at home and a good many have done some reading by themselves but they want some real directed study. The writer found that in a high school with an enrollment of about eleven hundred, in which previously there had been no club, it was only a very short time before a club of fifty members was flourishing. And it was not a passing enthusiasm. The membership kept up and the interest grew. Attendance at the weekly meetings was always good.

Aside from the knowledge gained, there are many other values to be derived from such an organization. The majority of the licensed amateur stations in a city are those of high school students. Having them organized gives a means for better controlling the radio of the city, for example, that of interference, closer observance of quiet hours and many others. This is a splendid opportunity for the development of cooperation.

This particular club was organized with the usual officers and the writer "elected" as instructor. An outline of the course of study was presented and for the larger part of each meeting the instructor lectured. It was found that the members had a good usage of the terms of radio but no clear understanding of them. And in order to make them clear the first meetings were given over to instruction in the underlying elementary electrical principles. It is essential of course that these be thoroughly grasped before radio theory can be attempted. A few simple illustrative experiments should be given for the benefit of those who have had no elementary science work in school. Following this the various fundamental principles of radio circuits are studied. Since nearly all of those interested in radio begin with its reception those principles were taken up first.

A set, both receiving and transmitting, should be constructed for the school. A loud speaker system may be installed in the auditorium. This can be used to provide entertainment at various times, such as music at noon, speeches of well known men or reports of basket ball games in which the school is interested. After the club is organized and its sincerity shown it usually is

not hard to get the necessary appropriation. Cooperation between the club and the manual training department will enable the club to make a great deal of the apparatus. Some of the members, having the mechanical ability but not the opportunity at home, will be able to construct the school set under the direction of the instructor or an experienced club member. In this way expenses may be kept down and too those doing the work will profit greatly.

In addition to the regular lesson at each meeting one member gave a paper which he prepared on some radio work he had done or had read about. The remainder of the meeting was given over to code practise. For this it was necessary to divide the club into groups of varying speeds. Older members gave code practise to the beginners and the instructor or a practised operator to the older members.

At the end of the first year the instructor of the club deemed it advisable to divide the club into two classes of members, Juniors and Seniors. The Seniors were those who could receive code at the rate of five words or more per minute and who had passed a test in theory, given by the instructor. For the second year and after, the Junior members were treated as beginners. The elementary theory and beginning code was given to them. The Senior members, who made up the smaller per cent of course, were able to take part in the discussion of radio theory. More advanced theory was taken up, they were given various experiments to try on the club set and report back results to the club. They were put in charge of the club set and held responsible for it. Some were able to give elementary work to the Junior members, thus assisting the instructor. A test on both theory and code was given at the end of each year to determine the member's rating. And too, in order to weed out the laggards, at the end of the first two months a very simple test on the theory already taken up was given and those not passing were dropped. This insured the Club of an industrious and eager group.

The problem of finding a teacher to handle this activity may be difficult for some schools. It is the writer's opinion that the physics department is the natural place to look for the instructor in such a subject. Apparatus for such work is already available in that department. The physics teacher already has the preparation in electricity and almost any university today offers a good course in radio theory in its summer school. This course ought to give a teacher a foundation for reading and study alone or for

a more advanced course later. The physics teacher should without a doubt be equipped to handle this activity.

The outline of study as used by the writer in lectures to the club is given very briefly.

I Elementary Electrical Principles

1. Static electricity
2. Current electricity
    1. Alternating and direct current
    2. Effects of electric current
    3. Resistance
    4. Conducting materials
    5. Potential difference
        a. Measuring of emf
        b. Ohm's law
        c. Sources of emf
3. Magnetism
    1. Magnetic field
    2. Magnetic field about a current
    3. Electromagnet
    4. Magnetic induction
    5. Applications
        a. Phone receiver
        b. Transformer
    6. Self-induction
    7. Mutual induction
4. Electric circuits
    1. Open and closed circuits
    2. Series and parallel connections
    3. Shunt circuit
5. Storage battery
    1. Elements of cell
    2. Electrolyt
    3. Specific gravity
    4. Chemical action in charge and discharge
    5. Care
        a. Height of electrolyte
        b. Use of distilled water
        c. Specific gravity tests
        d. Gassing
        e. Sulphating
        f. Care when putting out of use for a long period

II Fundamental Radio Theory.

1. Condenser
    1. Meaning of capacity
    2. Dielectrics
    3. Types of condensers
    4. Action of Condensers
    5. Nature of discharge
2. Oscillatory discharge
    1. Oscillatory circuit
        a. Effect of condenser
        b. Effect of inductance
    2. Frequency
    3. Damping
    4. Resonance
3. Transformer
    1. Principle
    2. Closed core vs. open
    3. Oscillation transformer
    4. Reactance
4. Electromagnetic waves

1. Ways of transmitting energy
2. Properties of wave motion
   a. Length
   b. Frequency
3. Kinds of waves
4. Propagation of waves
5. Theory of radiation from an oscillator
6. Action if detection

III Receiving apparatus and circuits.

1. Function of receiving circuit
2. Typical circuit for receiving
3. Detectors
   1. Crystal
   2. Tube
   3. Comparison
   4. Tuning Devices
   1. Loose-coupler
   2. Variometer
5. Coupled circuits
   1. Explanation of coupling
   2. Directly coupled circuits
   3. Inductively coupled circuits
6. Antennas
   1. Types-comparison
   2. Directional effect
   3. Action of the ground-counterpoise

IV Electron Tube.

1. Development of the tube
2. Electron flow in tube
   1. Two electrode tube
   2. Three electrode tube
   3. Discussion of characteristic curves
3. Electron tube as detector
   1. Detector action
   2. Effects of plate voltage, filament temperature
   3. Effects of grid condenser and leak
4. Electron tube as amplifier
   1. Principle of amplification
   2. Audio-frequency amplification
   3. Radio-amplification
   4. Regeneration
   5. Amplification in tube
5. Electron tube as generator
   1. Conditions for oscillation
   2. Circuits used for generating oscillations
   3. Beat reception

V Transmission

1. Function of transmitter
2. Damped and un-damped transmission
   1. Comparison
3. Apparatus for spark discharge
   1. Spark coil
4. High frequency alternator
5. Tube transmission
   1. Discussion of most commonly used circuits.

VI Telephony

1. Wave form used in telephony
2. Modulation
   1. Explanation
   2. Methods of procuring
3. Operation of tube radio telephony circuits
4. Line radio

THE PROPER CONCEPTION OF A NORMAL FORCE.

By R. T. Chase,
Salt Lake City, Utah.

In the writing of this, the author realizes that he is attacking a misconception that is as old, if not older, than Newton's works. This misconception seems to be founded on a half-truth statement of Newton's. This half-truth was all sufficient for the numerical values sought by Newton, but like all half-truths it is misleading, and has misled many who have sought to explain the reasons for these values.

How much do you know about force and the motions produced by force? Many people know that a stone dropped from a height will drop 16.1 ft. and gain a velocity of 32.2 ft. per sec. in the first second. Fewer people know how to compute the distance traveled and velocity gained under the influence of other forces than our earth's gravity. Fewer Still know how to compound velocities produced by separate forces, or how to compare dynamic with static forces.

In studying the motion of the moon, in a circle around the earth, Newton states that if the mutual gravitational attraction between the earth and moon were suddenly removed, the moon would travel in a straight line tangent to the circle in which it now travels, but because of the force of gravitation it is *continually drawn away from this tangent.* If you will examine any physics, or Text Book on Mechanics you will probably find, where they explain centripetal force, that they speak of the *normal acceleration* produced by the force. Are the motions described above produced by a static, or by a dynamic force? If centripetal force be not a dynamic force, then are not the above expressions very misleading to the student?

If we state that a velocity of 32 ft. per sec. has been produced in a distance of 16 ft. you immediately think of the earth's gravity, but do you know that these conditions could have been produced by an infinite combination of forces? Here is one example:

force	time	velocity	disance
2	3	6	9
32	0.25	8	2.5 = (1.5+1)
92	0.20—	18	4.5 = (2.74+1.76)
total	3.45—	32	16

Note in the above example that nearly 3.45 seconds were required to produce the velocity of 32 ft. per sec. in the distance of 16 ft. By reversing this example we find that we can state that, no matter how numerous the forces that produce a certain velocity (v) in a certain distance (d), their effect is equal. to a constant force of the value—

$$\frac{v^2}{2d}$$

You may have used the centrifugal force formula—

$$\frac{v^2}{r}$$

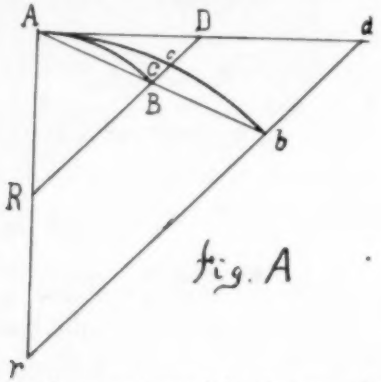
many times, but have you ever wondered why it had this peculiar form? Note that (r) is the distance, but it is one (r) and not (2r), and thus the formula is just twice that of an ordinary force.

The morning of this writing, while on the campus of the University of Utah, the writer heard a student tell a teacher and another student, as they appeared to be, that he had spent several hours trying to divide by zero. This was followed by a lengthy conversation between the second student and the teacher on the subject. As the writer was at the time contemplating writing this article, it seemed as though the conversation were being carried on as a timely hint as to how to make the reader understand fully the philosphy of the subject.

The problem of dividing by zero shows clearly that the ultimate term of the variable can not always be considered as equal to the limit of the variable. If we divide unity by fractions of continually decreasing value we will have quotients of continually increasing value. As the fraction approaches the zero the quotient approaches infinity, but the moment we tire of dividing the fraction, and, as it were, throw away the last piece, our quotient immediately jumps from infinity to unity. It seems to the writer that a new notation to show the reciprocal of infinity would be useful, such as $\frac{0}{\infty}$ called infinitesimal.

Turning now to Newton's Principia, Book I; Sec. I; Lemma VI; we read "If any arc ACB, Fig. A given in position is subtended by its chord AB, and in any point A, in the middle of the continued curvature, is touched by a right line AD, produced both ways; then if the points A and B approach one another and meet, I say, the angle BAD, con-

tained between the chord and the tangent, will be diminished in infinitum, and ultimately will vanish.



For if the angle does not vanish, the arc ACB will contain with the tangent AD an angle equal to a rectilinear angle; and therefore the curvature at the point A will not be continued, which is against the supposition."

This is Newton's opening argument on the curve, and motion in a curve. It is the axiom on which is founded much of the succeeding work of the book, and must be accepted or rejected by the reader before going farther. This seems to us, however, to be another case of throwing away the last piece, for it there be no angle between arc ACB and tangent AD, then either arc ACB has vanished and become equal to zero, or arc ACB has become a straight line, which is as much against the supposition as is the rectilinear angle.

Newton himself seems to have realized that in dealing with the curve the ultimate term of the variable could not always be considered as equal to the limit of the variable, and that his theory of limits did not fully explain the phenomenon, for in the scholium at the end of Sec. I. he says, "Perhaps it may be objected, that there is no ultimate proportion, of evanescent quantities; because the proportion, before the quantities have vanished, is not the ultimate, and when they are vanished, is none. But by the same argument, it may be alleged, that a body arriving at a certain place, and there stopping, has no ultimate velocity: because the velocity, before the body comes to the place, is not its ultimate velocity; when it has arrived is none. But the answer is easy; for by the ultimate velocity is meant that with which the body is moved, neither before it arrives at its

last place and the motion ceases, nor after, but at the very instant it arrives; that is, that velocity with which the body arrives at its last place, and with which the motion ceases. And in like manner, by the ultimate ratio of evanescent quantities is to be understood the ratio of the quantities not before they vanish, nor afterwards, but with which they vanish. In like manner the first ratio of nacent quantities is that with which they begin to be. And the first or last sum is that with which they begin and cease to be (or to be augmented or diminished). There is a limit which the velocity at the end of the motion may attain, but not exceed. This is the ultimate velocity. And there is the like limit in all quantities and proportions that begin and cease to be. And since such limits are certain and definite, to determine the same is a problem strictly geometrical. But whatever is geometrical we may be allowed to use in determining and demonstrating any other thing that is likewise geometrical."

However: Newton had a theory, and while analyzing and enlarging Kepler's law in Book I: Sec. II: Prop. I: Theorem I: he speaks of this theory in the following words "and therefore the centripetal force, by which the body is

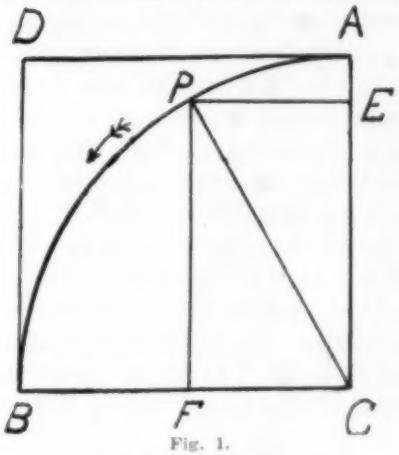


Fig. 1.

perpetually drawn back from the tangent of this curve will act continually." All writers on the subject since then try to make their explanation of the phenomenon conform to this theory, but we wish to show by the following that although this theory is right numerically, it is wrong and misleading theoretically.

The reason it is right numerically is because the velocity produced by a given force in half a given time is equal to half the sum of the velocity produced and the velocity destroyed by the same force in the whole of the same time.

Referring to Fig. I let P be a particle of matter moving in a circle with center C, velocity v, and radius r, in direction shown by the arrow. The particle is falling away from the tangent AD and is approaching the tangent BD, where its motion in direction A to D, or C to B must cease. Thus a constant force acting toward C must produce a velocity v through point B in direction D to B, or A to C and at the same time destroy a velocity which was v at point A in direction C to B.

Now let us find the value of the force required to accomplish this. For convenience we will consider the mass as unity and omit it from our calculations.

As the particle passes through the quadrant AB the force in direction PC remains constant while the force in direction AD varies as the line PE, and the force in direction BD as line FP. As the force represented by FP varies continually, we must, in order to obtain the total effect of all the forces represented by FP and acting to produce a velocity v of the particle through the point B, divide the time, represented by the arc AB into an infinite number of parts, and multiply each small increment of time by the corresponding force, and add the results. The same process with the varying line EP will give the total effect of all the forces acting in destroying the velocity v of the particle through point A. We know that the total effect of the two forces represented by EP and FP must be such as to produce or destroy a velocity v, and we know also that the velocity v is produced in the vector distance A to C, and destroyed in the vector distance C to B. As these two distances are the radius r, the total of the forces acting in either direction is equal to a constant force $\frac{v^2}{2r}$.

The constant force represented by PC must, in the time of ¼ revolution, do the same work as is done by both the variable forces EP and FP; that is, it must accelerate to velocity v and in the same time decelerate from velocity v, and it therefore equivalent to 2 times $\frac{v^2}{2r}$ or $\frac{v^2}{r}$ which is the

value of the centripetal force.

Now let us consider the conditions while our particle passes point A. Where shall we place our time and distance elements? The "falling away" theory places them with A at the beginning, or between A and P. An approaching theory would be just as reasonable, with A at the end. The proper place is with A in the middle. The "falling away" theory assumes the force as perpendicular to AD at A, whereas the average direction of force is perpendicular to a line joining the ends of the distance-time element at its center. With A at the center of the distance-time element the average direction of force is perpendicular to AD at A.

The nearest approach to a proper explanation of the principles involved in this problem is, we believe, to be found in "Duffs Physics." This author uses a hodograph method, but after making a good proof he bows to the popular conception in his last sentence by stating that the angle, which his proof shows, existing between the direction of the force and the line of entrance of the distance-time element, must be neglected as the element becomes smaller. However this line of force bisects the distance-time element and is therefore the average direction of the forces acting during that time.

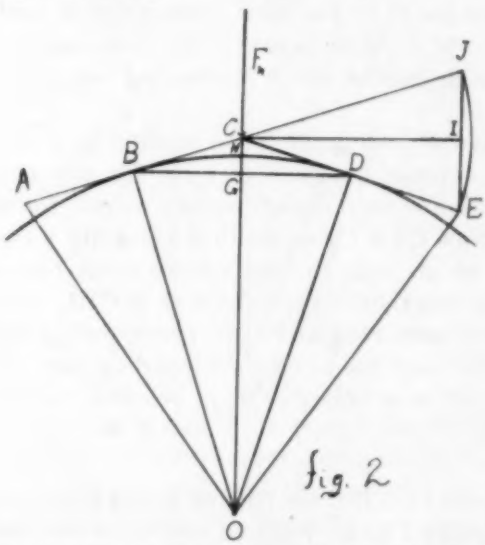


Fig. 2

Now let us consider the proof illustrated in Fig. 2. Let ABCDE be corners in the circumscribed and inscribed polygons of a circle of which BHD is an arc. Let us consider our particle as going in

direction from B to D. In this figure we have lines AJ, CI, CE, & BD which approach near the length of their respective arcs as limits, and any part of which when divided by the corresponding time element may represent the velocity. A number of combinations may be used to calculate the value of the force F_n. We will use the one forming the hodograph to the arc BHD relative to the triangular sector BOD of the inscribed polygon, and the sectors AOC & COE of the circumscribed polygon. As AJ represents the velocity and direction at B, and CE the velocity and direction at D, we have JE representing the relative change of velocity in time BD. JE divided by (unit of time BD)$_2$ is to the velocity (CE divided by the same unit), as the velocity (BD divided by the same unit), is to the radius DO, or $F_n:v::v:r$ and

$$F_n=\frac{v^2}{r}.$$

The reader will observe that the hodograph triangle JCE is also similar to triangle COE, and so the same numerical value for F_n can be obtained from these relations, but on closer observation he will note that triangle AOC is also needed to obtain JCE and that the middle points B & D determine the direction of lines CJ & CE, and this brings us back to the same time element that obtains for the inscribed triangle. Thus we may obtain our value for F_n by the same process that is used for obtaining the value of π, which is a process of averaging a larger and smaller variable each of which approaches but never reaches the limit.

The triangular hodograph when applied to a circle will give the correct average direction of force for any angle, but the numerical value is only approximately correct for small angles. Now if we draw CJ & CE equal to the velocity v and then draw the arc JE we are able to obtain some exact relations, for the sector JCE is exactly the same shape as BODH. Any part of the arc JE has the same relation to the corresponding part of arc BD that any other part has to its corresponding part. Thus normal velocity arc JE is to velocity CE as velocity arc BD is to radius

$$\frac{JE}{t^2}=\frac{v^2}{r}=F_n.$$

You will note that at B the particle is going with relative direction and velocity I to J. For half unit time this velocity would be represented by half IJ, or GC. Our particle must stop its motion in this direction in this half unit time, and its travel would be represented by GH which is $\frac{1}{4}$IJ or $\frac{1}{2}$GC. A relative

motion from H to G takes place in the last half of our unit time, and thus broken line BCD is depressed into an arc of the circle BHD.

If we use the impulse idea as used by Newton in enlarging on Kepler's law, we must have the impulse applied at C (Fig. 2). Let BCD be three consecutive points in the arc of a circle. Then CJ, CI, & CE are three tangents to the circle at point C. CJ and CE approach CI as B & D approach C, but just as B, C, & D are consecutive points, so are CJ, CI, & CE consecutive tangents. The old theory states that the particle, if released at C will go in the direction CI, but according to our present assumption this is not so, for the particle at the moment of release was going from B to C, and if released would go from C to J. Now if our impulse is to put the particle in position D it must be applied in direction CO, and this is not normal to the direction of free travel.

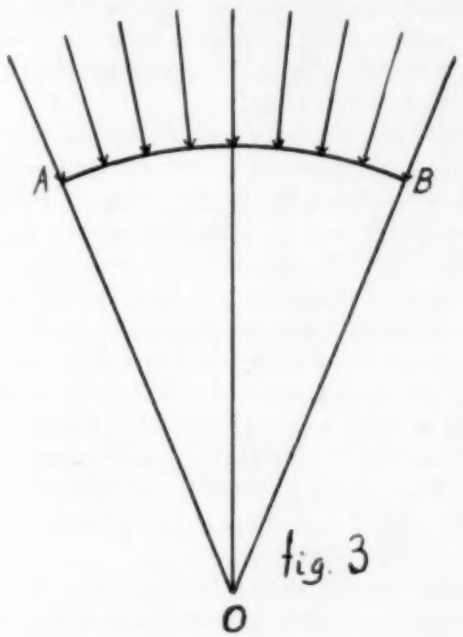


fig. 3

You will note in Fig. 3 that the arrows represent the direction of normal force; the one in the middle being the *average* direction. Now when one tries to explain the phenomenon by the popular theory he immediately gets into trouble, for, suppose we start our normal acceleration at A, and normal acceleration is the right name, for we apply a force normal to the path of the particle and an acceleration is the result. The velocity caused by this acceleration must be compounded with the existing velocity, and

so we will have an increasing velocity. The popular way of getting around this difficulty reminds one of Joshua or the daylight saving advocates. Time is supposed to be stopped by dividing it into such small portions that it can not be measured, and the velocities become so small that they can not be compounded.

It might seem at first thought that by dividing the time into small portions, the angle between the forces at the end and middle of the arc becomes so small that it may be neglected, but the fact is that the effect is cumulative, and each time that we divide the time we must multiply the effect by the same factor. To illustrate this let us start with an angle of 90° in which the average force is 45° from the entrance direction. Now divide the 90° by 3 and we have in the same time, 3 sections of 30° each in which the average direction of force is 15° from the entrance direction, or a total in the 3 sections of 45°. Divide again by 3 and we have 9 sections in which the average direction is 5° from the entrance, or 5°x9—45° total. Thus no matter how much we divide the angle, the total deviation of the entrance direction to that of the proper, or average is the same.

In talking this problem over with those who have studied the subject, we find a willingness to acknowledge the proofs according to the new method as correct, but an unwillingness to acknowledge the old way as wrong, so as the purpose of this article is to show the difference between the right and wrong way we will give another illustration of how the old way is wrong. The old way starts with the assumption that the particle moving in a circle is, at a certain point, moving in the direction of a tangent of the circle at this point. No consideration is taken of the conditions existing before this point is reached. Now if the particle becomes free at this point, it will travel with the same velocity that it had at the moment it was released, along the line of this tangent, but if it is not freed there must be a force that forces it out of this direction.

Here is where the old theory breaks down, for a force to be effective must work during a finite time, and during this time the particle will continue to move in the direction of the tangent. To illustrate this point let us draw Fig. 4. Here AC represents the tangent at point B, and the particle is going in direction A to C. P_n. represents the force applied perpendicular to AC. Now in the time it would take the particle to travel from B to C, a velocity represented by CB^1 would be caused by the force P_n. This, compounded with BC gives us $BB,^1$ which is greater than BC. By using the new direction and velocity, and applying the same

force perpendicular to the direction of travel, we obtain triangle B′C′B″ in which B′C′ = BB′, and angle C′B′B″ is less than angle CBB′. By continuing this process indefinitely, and making our time for each triangle so small that BB′ etc. are consecutive points of our curve, we find that we have produced a spiral instead of a circle. This is a diagram of velocities. The distance traveled would be only half CB′, but the relative results would be the same if that were shown. Some to whom this diagram has been shown have said, in trying to defend the old theory, that the average direction of P_n should be used. No better proof of the new theory could be obtained, for by doing this they indicate the proofs illustrated in Figs. 2 & 3, and show that the conditions before as well as after passing the point must be considered.

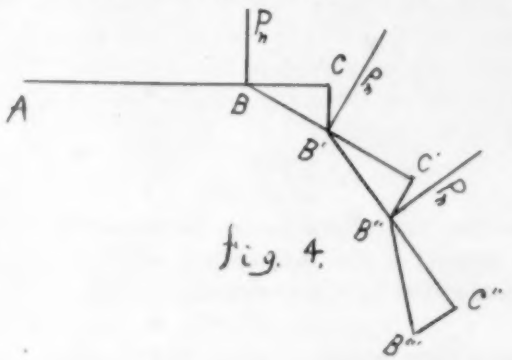


fig. 4.

This same problem of dividing by zero seems to be troubling some of our more mature scholars these days. As an example let us turn to Prof. Einstein's book "Relativity." The first six sections of part one seem so be devoted to breaking down our faith in our ability to reason; or, they may be considered as destructive sections. In section VII he speaks of a phenomenon, which seems to have been proved by experiment, and which he has tried to relate with other laws of nature by a theory: viz; the fact that a ray of light seems to have the same velocity relative to the absorbing body regardless of the relative velocities of the absorbing and producing bodies.

This phenomenon, if it be true, can be explained according to either theory of light, without in the least interfering with our present knowledge of the laws of nature. If Newton's theory of emissivity be correct, it is only natural that the particles be emitted at varying velocities. Then it is only a matter of our eyes picking out the ones arriving at 186,000. miles per second,

If the wave theory be correct, then is it not again possible that the waves are of varying velocities, and our eyes are tuned only to those arriving at 186,000. miles per second.

In sections VIII to X Mr. Einstein tries to illustrate his theory by means of a man in a moving railway train observing two simultaneous strokes of lightning which occur along the straight track. Here Mr. Einstein fails to observe the fact that the man on the train, if he have an ordinary education would provide himself with a range finder and stop watch, and then calculate his distances and velocities. Then if it be true that we observe only the light that arrives at 186,000. miles per second, he must allow for that fact in his calculations.

In sections XI & XII Mr. Einstein begins the construction of his theory, and we learn that it is founded on the "Lorentz Transformation," a derivation of which is given in Appendix I. We will quote one paragraph of this derivation. "A light-signal, which is proceeding along the positive axis of x, is transmitted according to the equation

$$x = ct$$

or

$$x - ct = 0 \quad \ldots\ldots (1)$$

Since the same light-signal has to be transmitted relative to K′ with the velocity c, the propagation relative to the system K′ will be represented by the analogous formula

$$x' - ct' = 0 \quad \ldots\ldots (2)$$

Those space time points (events) which satisfy (1) must also satisfy (2). Obviously this will be the case when the relation

$$(x - ct) = \lambda(x' - ct') \quad \ldots\ldots (3)$$

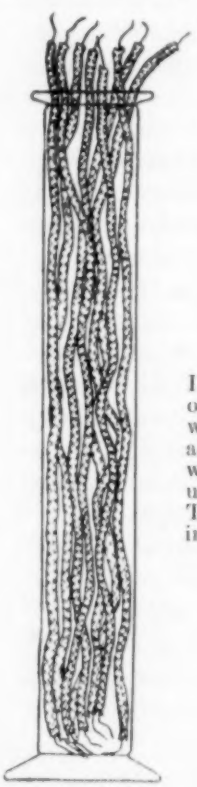
is fulfilled in general, where λ indicates a constant; for, according to (3) the disapearance of (x—ct) involves the disappearance of (x′—ct′)″.

We have now arrived at the zero hour, and it is the same old zero trouble. We have (x—ct) equal to nothing, and (x′—ct′) equal to nothing, and thus we have nothing to work with; but—Mr. Lorentz takes one of nothing; makes it equal to an indefinite number of other nothings, and thus we behold the foundations of a beautiful air castle of theory.

For the benefit of those, who, through the prejudice of having looked at such problems in the old way for years, are not able to see the mistake, we will explain it in detail. Mr. Lorentz takes a quantity x, which in this case is an indefinite quantity (not an unknown quantity, or a variable approaching a limit) equates it to ct, c being a definite quantity and t an indefinite quantity.

Then he subtracts from x the equal quantity ct and the result is zero or *nothing*, but the inference is that the bracketed expression $(X—ct)$ is a variable approaching zero as a limit. The equation $(x—ct) = (x'—ct')$ is true even if x be measured in miles or light-years, for $O = nO$, and in all further manipulations of these expressions it must not be forgotten that they are equal to zero and nothing else. This problem is very much like the algebraical catch problem which starts by letting A—B and ends by proving that one is equal to two. No mistake can be found in this problem, but after studying it awhile one discovers that it only proves that one zero equals two zeros.

Before closing let us consider another common mistake; viz. the equating of a variable with a constant; the inference being that the limit of the variable may be substituted for the ultimate term of the variable. In some problems the difference between the ultimate term of the variable and its limit becomes so small as to make no difference, but we must always remember that there is a difference. No matter how large n may be the difference between $\frac{1}{n}$ and O is $\frac{1}{n}$, or $\frac{1}{n}—O = \frac{1}{n}$.



STORAGE FOR SHORT WIRES.

By Edward E. Ford,
West High School, Rochester, N. Y.

In a recent issue of School Science and Mathematics I noted a request for a method of storing short lengths of wires used for electric connections. I enclose herewith a sketch representing a glass hydrometer jar about 15 inches high and 2 inches inside diameter, which we find very convenient for such storage. We use No. 18 rubber covered wire, cut to 16-inch lengths. Two jars furnish room for all necessary wires used in the laboratory and lecture room.

SOME PROBLEMS IN THE TEACHING OF PHYSIOGRAPHY IN THE HIGH SCHOOL.*

LYNN H. HALVERSON,
Joliet, Illinois, High School.

It was with some misgiving that I accepted the honor of filling in on this program when your chairman approached me. Though I have had a number of years experience in teaching college physiography and geography, and other experience in secondary schools, this is my first year as a teacher of physiography in the high school. The major part of what I will discuss applies to the teaching physiography to freshman in the high school.

Yet is it probable, that being dropped rather abruptly into the problems of teaching high school physiography, lends strength to my position. I am not committed to any specified line of procedure. I feel entirely free to express any thoughts which may come to me. At the same time I believe that I have a greater appreciation of the problems of the subject than I shall ever have again. Given a year or two, and one will develop a way of handling the subject, a way adapted to the particular school in which he is teaching. And when that time arrives for me, I shall not have the keen appreciation of the problems involved in the teaching of physiography in the high school that I have to-day.

It is well, I believe, to consider for a moment from a general viewpoint, the subject of physiography as taught in the high school. It would be possible to spend hours discussing what physiography is and what it is not, particularly from the standpoint of the high school. In some high schools it is a required subject, which all students enrolled must study. It is commonly given in the first year of the high school. It is a study whose subject matter is now well organized and fairly definitely delimited, yet the course as actually taught in many high schools varies widely, depending directly upon the training of the teacher. And unfortunately, there are comparatively few teachers, especially outside the larger school systems, who are at all adequately trained in geography or physiography.

As a result I know of at least one place where a course in general science is given under the heading of physiography. In another case a course in general geography is called physiography. These practices are particularly prevalent where physiography is required for a certain grade of teacher's certificate, and is

*Delivered before the Geography Section of the Central Association of Science and Mathematics Teachers, November 28, 1924.

therefore taught in all the so-called "normal training" high schools. Numerous instances might be cited in which, one might say, the name physiography has been taken in vain.

While such phases of the teaching of physiography might be considered outside the province of this paper, it seems to me well to keep such facts always before us. A very enlightening discussion of physiography in the high school, especially in relation to other subjects, took place some fifteen years ago. The Journal of Geography was the organ in which much of the geographical side of the discussion appeared. In going over the files of that period recently there were two papers which seemed worthy of mention to-day. I give the titles in the order in which the articles appeared in the Journal.

Professor Fenneman discussed the subject, "PROBLEMS IN THE TEACHING OF PHYSICAL GEOGRAPHY IN THE SECONDARY SCHOOLS," in the March, 1909, number. In the November, 1910, number, the late Professor Salisbury discussed the subject, "PHYSIOGRAPHY IN THE HIGH SCHOOL." These articles are in the main as apropo to-day as on the day they were written. They are articles that every teacher or prospective teacher of physiography would do well to read, and re-read.

It may appear that in the very beginning I am digressing from a strict adherence to my subject. But I feel strongly that the problems involved in the teaching of high school physiography are broader than just the problems of the teacher from a purely pedagogical standpoint. The teacher must first consider the subject itself, its background, and its history, including its struggle for existence in the high school curriculum. After some consideration of the favorable and unfavorable critisicm of the subject, one is better fitted to go ahead, even then with caution, in an endeavor to make physiography an interesting and useful subject for the high school freshman, regardless of whether or not he will ever complete his high school course and go on to an institution of higher grade.

In the actual teaching of physiography in the average high school we are met with problems on every hand. There are the problems of the texts to be used, the problems of organization, involving the arrangement of the laboratory periods, the problems of laboratory equipment, apparatus, and maps, and finally, the problem of field work, involving locations, the time element, and sometimes transportation. This is a very generalized state-

ment of some of the problems, in detail they bulk much larger.

They are not problems which can be solved once for all in any summary manner. They continually re-appear in the same school in different guises, while if one has the courage to change schools he is certain to meet a new aggregation with bewildering characteristics.

The Problem of Selecting a text.

It is possible to begin the actual discussion of the problems of teaching physiography with something tangible. The text book to be used in teaching physiography in the first year of the high school offers one of the first real problems. Just suppose that *you* were to go to a strange high school as head of the physiography and geography work. I believe that it would be fairly easy to select good geography texts, but physiography offers quite a different situation. I will say at the outset that it is not my intention to put forward any text that at all meets the requirements. We will grant that it is not necessary to teach all that is in any one text, but even then how much better off are we?

In short, it appears to me that it is not a question of what treatment one likes best, it seems rather to be a question as to whether any of the books have been written for the high school freshman. Books which may be admirable from a technical and scientific standpoint may not be at all teachable, or even interesting viewed from the standpoint of the high school freshman.

Yet if one reads the prefaces of a number of the comparatively recent books used in high schools at the present time, it is clear that the authors were aiming in the right direction. There is a desire to avoid technicalities which in some cases appears to have resulted in a rather forced simplicity. Yet all are lacking in the type of practical applications to local problems which hold the interest of the student. With a well-trained and versatile teacher, even without very suggestive material in the text, all the necessary "local color" may be well worked in, and the application side of the course not suffer. But such trained teachers of physiography in the high school are the exception rather than the rule. There is, then, a need for a new text book in physiography. This book should treat more largely than has been done with the applications of the principles of physiography in every-day life. It should show the student that the commonplace every-day activities of his family reflect the influences

of his physiographic environment. It should aim to make physiography the most alive and practical science course in the high school, perhaps the one science course which can have general recognition as having an unquestioned practical, as well as cultural value, regardless of what occupation the student may follow in later life.

The question immediately arises as to what is to be done until the ideal book arrives, if it ever does. Fortunately, there are a number of good books from the standpoint of subject matter, though one cannot feel that any of them meet the teaching requirements.

To suggest one way in which the problem is met, I shall outline briefly the plan at Joliet. The time allotment there makes the following arrangement possible: it may not be practicable for schools with other time allotments. Every class room, or class room-laboratory, for that is what they are, is equipped with two complete sets of texts, namely, MODERN GEOGRAPHY, by Salisbury, Barrows, and Tower, and LESSONS IN PHYSICAL GEOGRAPHY, by Charles R. Dryer. In addition, there are available for class use copies of ELEMENTS OF GEOLOGY, by Blackwelder and Barrows, and ROCKS AND MINERALS, by Fairbanks, the last a book written for the elementary school. In the school library are copies of PHYSICAL GEOGRAPHY, W. M. Davis, PHYSICAL GEOGRAPHY, Gilbert and Brigham, as well as a few other books, making a total permanently in the library of about thirty-five. The students own no books, but do pay a small sum as a book fee.

Discussion of the merits of the above books is purposely avoided. A teacher at Joliet has the privilege of using any or all of the above. The work is unified and summarized in the note book exercises, which include the reports on all field trips. This is one way the lack of any one satisfactory text may be met. It has advantages and disadvantages. In principle, I am in favor of each student owning a basic text, giving him something to tie to in times of stress and reinforcing the note book in making a unit of the course.

No mention has been made of Salisbury's HIGH SCHOOL PHYSIOGRAPHY. Having used the book with college classes, of course with extended outside readings in more advanced texts, there is some doubt in my mind regarding using it with high school freshmen. The language is simple, but the thought is not.

It appears, then, that there is a "text-book" problem in teaching physiography. It is true that in no subject can the breath of life be provided by a textbook. On the other hand, a text-book which is alive, practical, and suggestive, cannot fail to be a powerful instrument in the hands of the teacher.

THE TIME ALLOTMENT OF PHYSIOGRAPHY.

A second major problem facing the teacher is the time allotment given the subject in many schools. To me, it appears an impossibility to teach physiography in a very satisfactory manner if only one period of approximately forty-five or fifty minutes is available each day. In the smaller schools where this condition generally exists, the teacher of physiography teaches one or more other subjects and any more time would not fit into the teacher's teaching program.

However, in the larger schools it is possible to have time for laboratory as well as class work. The time given depends largely upon the organization of the school, making this phase of the problem somewhat complicated, for the co-operation of the administrative officers of the school is first necessary. There are at least two ways in which the time requirements of physiography may be met.

Commonly there are the so-called laboratory periods, coming on certain days of the week at specified hours. Under this plan there is a more or less definite break between the class and laboratory work. If any work is slighted, it is liable to be laboratory work, *which should be considered the more important*, if anything. In general, however, the covering of pages in a text comes first.

A second possible way of handling all the laboratory and shop work in a high school appears to me the more satisfactory from the standpoint of teaching physiography. Under this plan all science and shop courses meet half again as long as the ordinary classes, each day. These classes are balanced against each other, and it is only when a student is irregular as a result of failure, that odd time results which must be spent in a study room. This plan makes it possible for the teacher to work in the laboratory and note book work with the text-book, making a unified whole.

Yet it is probable that ninety per cent of the physiography in the high school is taught without laboratory or field work. The only way to improve this condition is to have more trained teachers of physiography who will influence administrators to

so organize their high schools that the needs of this particular science, as well as other science courses, can be better served. The above plan simplifies programming for the administration, and in the end gives a much better balanced schedule from the standpoint of the pupil as well as the teacher, as the class periods are the same for every day in the week.

I believe that we will all be agreed that physiography without the proper time allotment is unsatisfactory from all viewpoints. One of the important problems of the teacher, then, is to obtain the required time, without disrupting the organization of the school.

The Physiography Laboratory.

Much has been said, and much has been printed, regarding the laboratory equipment requirements of physiography. Time does not permit any discussion of the equipment problem, but it seems well to say in passing, that it seems to me there is real danger of burying the practical content of physiography beneath too elaborate laboratory equipment. Physiography, in the hands of a well-prepared and interested teacher, with a fair allotment of time at his disposal, can be very well taught with an unbelievably small amount of laboratory equipment.

Field Work In Physiography.

The most important single aid in making physiography practical, popular, and intelligible to the high school student is the thoroughly planned and carefully executed field trip. Yet many teachers are faced with apparently insurmountable obstacles to such trips.

To find a satisfactory location is generally the first problem. A number of different locations are necessry as different phases of the work are taught. If you are in a large high school where physiography has long been taught, you are fortunate, for your predecessors have undoubtedly found many suitable locations, and may have gone so far as to have worked out mimeographed sheets of suggestive material. If such is not the case, it will be necessary to comb the region for locations. In experience in several states, I have never failed to find locations which were fairly satisfactory, even though at the outset conditions looked very unfavorable. There were generally more locations than hours in which to visit them. I realize that in a city the size of Chicago it may be exceedingly difficult to find locations which are accessible. Yet very worthwhile locations may develop with

the digging of basements, of sewer lines, etc., but such locations are very short-lived. In some of the parks there are locations which may well be used.

The finding of locations can come only through the activity of the teacher in covering the home region. To unearth good locations, the teacher must have an aptitude for or training in geographical field work and then be willing to spend some week-ends in tramping over the area. The latter should be a pleasurable duty. If the teacher dreads field work, and looks forward to getting it over, the same attitude will be very quickly found among some of the students.

The time element enters in again in relation to field work. Without a proper time allowance, little field work can be done. With an hour and a quarter to an hour and one-half at one's disposal, trips of over a mile from the school may be made, provided everything is well organized. But even this amount of time is not enough, for perhaps the best location requires even more time to be reached and studied carefully. Such a situation may be met by securing permission to have your pupils dismissed from their other morning or afternoon classes on one or two occasions during the semester. This is done in some schools, and gives the teacher a half-day in which to make a field study.

The importance of field work cannot be over-emphasized, for it is in this work that the teacher has the greatest opportunity to hold the student's interest. In this work are found the practical applications of physiography which make it live.

Conclusion.

In summary, I wish to state what seem to me to be some of the fundemental requirements for the more satisfactory teaching of physiography in the high school.

First, A well-trained teacher.

Second, A better text than is now available, a text which will be enlightening and helpful to the experienced teacher and one which will be a revelation to the poorly equipped teacher.

Third, Following more or less directly as a result of the motivating effect of the first two, a time allotment for physiography which will harmonize with the way it should be taught.

And Fourth, made possible by the preceding three advances, a field work program which clinches the practical application of the principles taught, leaving the pupil a practical concept of the influence of his physical environment which can never be taken from him.

HELPS FOR BIOLOGY TEACHERS.

By W. C. Croxton,
University of Illinois, Urbana.

As a teacher of biology, I appreciate assistance; not that overstimulation by the gifted speaker, which leads me at the moment to feel that I am the closest follower in the footsteps of that greatest of all teachers, but which is always followed by that inevitable relapse leaving no means by which I can achieve those things to which I aspire. My preparation has many times been inadequate for the teaching of something which seemed most worth while. I am convinced from the types of requests for assistance which we receive from biology teachers each year that my experience is not unlike theirs.

There are over 400,000 described species of insects. A considerable portion of our biology texts is devoted to this group. Most high school teachers have not had a course in entomology, or at most one course. Nor could they hope to know all of the insects of their community if they devoted their lives to this study. We are daily forced to say, "I don't know." Do we need aid? Insects are only one of many phases of our subject. The information with which we are attempting to aid students to interpret the most mysterious of all phenomena in our communities is very meagre for the task confronting us.

But there are other reasons why we should be on the alert for the latest and most complete information on any aspect of our work. Science is changing and expanding and it is altogether likely that many things are being taught in our biology classes as scientific facts, which really are no longer true. May I illustrate from insects again. The San Jose Scale is one of the ten worst insect pests of the Central States. This high school text-book in biology which I pick up states that lime sulphur is the best control measure. This is not true in our region. Lime sulphur although apparently successful on the west coast, failed to control the San Jose here. Miscible oils have proven much more effective.

It is difficult to keep up with the advancement in scientific knowledge, but a still greater task confronts the teacher of high school biology. Only a small part of the biological publications are readable by high school pupils and the sincere teacher is ever on the alert for simple statements of the discoveries of science. Perhaps the class is studying fishes. You have taken them to the fish market and built a number of problems about our common food fishes. You need a good bulletin on whitefish, another on

carp, etc. Where are they to be obtained? Your text-book affords only a bare mention of each. You realize that our streams are largely polluted; that if we do not arouse our classes to the need of conservation and to regard for other living things upon the earth, we can hardly expect those persons who are not students of life sciences to do it. But where is the class to obtain the information concerning stream pollution and the recent wide spread movement to prevent it? The same question confronts the teacher when she teaches birds, plant diseases, and in fact every phase of biology. I hope that the list of sources of material which I have prepared for distribution here to-day and the few suggestions I have to offer may be of use to some teachers in enriching the biology course. This list is neither annotated nor evaluated, although the sources are selected. It does not contain titles of the publications available. Publications are daily being exhausted. New ones are replacing the old. However, it is a large task to evaluate the publications and determine those of greatest use in high school classes. Rather comprehensive work along this line is in progress at the present time at the University of Illinois, an evaluated list of available material on each phase of biology will be published during the year. In this publication, the most valuable materials will be starred and the uses for which they seem most suited will be indicated. If you wish to secure this help it would be well to record this reference at this time as it is not included in the bibliography for distribution to-day. Address your request to the Bureau of Educational Research, University of Illinois, Urbana, and it will be sent you free of charge as soon as it is available. I have also been able to secure for distribution to-day copies of "Sources of Moving Pictures" to be used in teaching biology, together with other information on Visual Education prepared by Dr. F. D. McClusky of the University of Illinois.

When the teacher begins the collection of biological helps systematically, he does not find a scarcity of material but is impressed by its very abundance. The first step is to decide the type of material desired. This will depend upon the phases of biology which are to receive major emphasis and will probably not be the same in Senn High School as in Danville, Indiana. In addition to the local factor, let us keep in mind one other consideration in deciding along what lines to build our supplementary materials. We may well sacrifice the study of liverworts, most marine animals and many other forms of great interest to us in

order that we may teach more of the improvement of our plants and animals, disease carriers and pests and their control, the manifold work of bacteria, foods, conservation, and other studies of equal bearing on our daily lives.

The first tendency is to order every publication which is in any way connected with biology. But biology is a broad subject with many ramifications and the teacher will do well to begin by collecting materials along a few lines of greatest emphasis. We must keep in mind that all of this material must be examined and we must know exactly what it contains before we can direct our students to it. The mere accumulation of material is of little value.

A great deal of material may be secured at little or no cost. Much of it is likewise of little value. A few publications are of exceptional value from cover to cover; some have a few pages of valuable general discussion in the introduction; in some the conclusions only are worthy of the high school student's time; some are are readable only by the teacher; others by the more capable students in the class; some are valuable only for the illustrations. Many untrue or exaggerated statements are to be found in some of the private publications available. It is therefore important that the teacher carefully examine these sources and discard much of the material obtained in this way.

Notwithstanding the very evident limitations of fugitive material, its advantages in the enrichment of the biology course is so great as to make it highly worth while. It seems to be the best solution of the problem encountered by so many teachers of biology; that of obtaining supplementary materials for class instruction at a minimum of cost.

To study the effect of sunlight in treating tuberculous children the London county council last summer conducted an experiment in which 35 boys attended an open-air school wearing very little clothing, so as to allow their bodies to be browned by the sun. As a result of a few weeks of treatment the boys appeared to be more alert, more energetic, and happier, according to the report of the head master of the school. —[School Life.

A "trouble bureau" is operated by the Service Citizens of Delaware, an organization which co-operates with the State department of immigrant education in preparing foreign-born persons for citizenship. More than 1,000 problems concerning naturalization were presented to the bureau during the past year by 746 applicants who needed help. These applicants represented 33 nationalities.

SCHOOLMASTERS CLUB SCIENCE COMMITTEE REPORT ON SCIENCE.

ELLIS C. PERSHING, *Chairman;* CHAS. A. MARPLE, H. P. HARLEY, C. H. SALTER

Cleveland, Ohio, School of Education

REPORT ON PHYSICS

By CHARLES A. MARPLE
Central High School

Nearly two years ago the Chicago Schools made a study of objectives in the teaching of physics and received replies from eighty teachers of physics not only in Chicago but from several other large cities. Some of the members of this club may have received the list as did the writer.

Last fall when a committee from the School Masters Club was appointed to make a study of Science in the High Schools of Greater Cleveland it was decided to undertake two things—first, concepts which might be expected to have found some lodgment in the brain cells of pupils who had recently been exposed to one year of said science and second, the objectives of the teachers of that science. You may not agree with the fifty concepts in physics finally selected. It will be an interesting experiment for teachers of physics here to sit down and write out the concepts which they think should mean something to a pupil just having completed a year's work in the subject—and then bring this list down to fifty. Our lists ran up to sixty or seventy-five and is was very difficult to eliminate and bring them down to the agreed upon number fifty. Some of those you might like better may be missing.

The Chicago list of teacher's objectives seemed quite complete and no changes were made. Cleveland physics teachers were asked to add any other objectives they might have in mind and not only two teachers out of twenty-five added anthing. One teacher changed one work in the objective "i"—"playful" to "purposeful." The other teacher added eleven words to "i"—" and to make physics of practical value in their own lives. From these few additions we may conclude that the list of twelve objectives sent out was fairly comprehensive.

Turning to Table I where results of this study of teacher's objectives in physics have been tabulated and to the right hand column headed "Range" we see that at least seven out of the 12 objectives were ranked by someone as number 1—while four

were ranked as 2 and one as 4. That is all but one of the 12 objectives were ranked either as first or second choice while every one but two were ranked as the lowest or next to the lowest. This is surely a wide variation.

Not one of the twelve objectives received a majority of the twenty-five votes for first place. The highest vote received by any for first place was 9 for "E." You will notice that the average rank of "E" is tied with "G"—both being 3.7. The only objective receiving a clear majority was "i"—14 votes out of 25 for last place. It also had the lowest average rank —10.7.

We may take some comfort however from the fact that though none received a majority we agreed with the eighty teachers in the study made in Chicago in ranking —"E" first, "G" second and "C" third, and we likewise agreed on the three tail enders— "K"—"L"— and "I" 10th, 11th and 12th respectively.

There was considerable variation in the Cleveland and Chicago ranking of the 6 objectives falling between the first three and the last three.

Referring to Table II in the top of the concepts marked by the pupil as useful, the percentage finding it useful exceeded the percentage answering correctly. As for example, concept number 1 only 12.2 per cent answered it correctly while 35 per cent found it useful. In numbers 7-8-20-26 and 11, wide variations in these two percentages were also found.

In Table III an attempt was made to see whether the number of questions answered correctly has any relation to the number of sciences studied.

In some of the High Schools chemistry is taught in the second year—which will account for the large number of pupils studying Chemistry before Physics. This likewise tends to increase the average number of sciences studied.

A year or more ago at Central High, one of our teachers— Mr. Beer, made a study as to the value of general science to a student in his study of physics; and it was found those having had general science before taking physics did on the whole considerably better than those who had not had general science. The results of the present study seem to be negative and no conclusion can be drawn. The average for each of the four groups as to number of sciences studied is nearly three.

Each pupil was asked to indicate which part of the course in physics was most valuable to him and also how he would improve the course.

Seventy-one pupils stated that electricity was most valuable to them—more than thirty-six per cent. Fourteen gave mechanics, thirteen light, seven sound, five laboratory work, and three heat as of most value.

There was but little help gotten from the answers to the question on how to improve the course. Eighteen said to make it more practical—eighteen being less than ten per cent of the total number of pupils answering the question. Twelve said to have more experiments, three more electricity, three wanted more time given to the subject, two wished for wireless, two for more laboratory work, one for moving pictures, and one for separate classes for girls and boys.

Objectives in Physics

To the Teacher: Please rank the following objectives in order of importance by placing (1) before your first choice and (2) before your second choice. For example, if you consider the objective (c) first in importance, place 1 in the space for ranking before (c) and so on through the list. *If you have other objectives for your subject please add them to the list.*

Rank

..... (a) To satisfy the natural interests in the things and forces of nature with which men are surrounded and with which they must deal to give the information which is interesting purely for its own sake.

..... (b) To give information about those appliances which science has developed and which are useful in making for greater comfort in the home and community.

..... (c) To provide opportunity for acquaintance with the elementary laws of nature which aid in understanding those citizenship problems which arise in connection with such topics as development of water power, problems of transportation, lighting, etc.

..... (d) To provide opportunity for the student to become acquainted with the applications of physical science to industry for the purpose of educational and vocational guidance and possibly to furnish a beginning of vocational training.

..... (e) To contribute such specific ideals, habits, and concepts as those of accuracy, achievements, persistency, openmindedness, proof honesty, cause and effect, etc., which are essential to the study of science.

..... (f) To develop system, order, neatness, accuracy and possible other attributes to the end and that they will function in the ordinary affairs of life.

..... (g) To develop such broad concepts and natural laws as the laws of gravitation, conservation of energy and others to the end that science and reality may function in place of superstition and ignorance.

..... (h) To afford in some measure an opportunity to show the importance of scientific research and to stimulate the spirit of investigation and invention on the part of the student.

..... (i) To give to children a full opportunity to indulge in the playful manipulation of toys, tools, machines, etc., in order that they may explore the world of reality as widely and as deeply as possible.

..... (j) To give to pupils a broad and genuine appreciation of what the development of the science of Physics means in modern, social and industrial life.

..... (k) To make pupils able to read more intelligently and with greater interest, the articles on Physics in magazines and in scientific books of a popular character.

..... (l) To give such training as will result in increasing respect for the work of recognized experts.

To Teacher: Please have questions answered by pupils who have finished one year physics.

To be answered by the pupils. Time 2 (45 min.) periods.

(a) Please check below the science which you have studied. Biology..... Botany..... Chemistry..... Physics..... Physical Geography..... Physiology..... General Science..... Nature-study.....

(b) Place (u) before each term listed below which is useful to you in some way—in your play, work, reading, etc.

(c) What part of the Physics course is most valuable to you?

(d) How would you improve the course?

(e) State in your own words what each of the following terms mean to you.

1. Fundamental Measurements
2. Force
3. Mass
4. Force of a Pound
5. Work
6. Machine
7. Power
8. Mechanical Advantage
9. Efficiency
10. Conservation of Energy
11. Conservation of Matter
12. Gravitation
13. Barometer
14. Heat Energy
15. Molecular Theory of Heat
16. Calorie
17. Latent Heat of Melting
18. Latent Heat of Vaporization
19. Specific Heat
20. Manufacture of Ice
21. Gasoline Motor
22. Quantity of Heat
23. Musical Sound
24. Pitch
25. Major Triad
26. Musical Scale
27. Magnet
28. Declination
29. Lines of Magnetic Force
30. Static Electricity
31. Induction
32. Ampere
33. Volt
34. Ohm
35. Ohm's Law
36. Fuse
37. Watt
38. Dynamo
39. Direct Current
40. Alternating Current
41. Telephone
42. Reflection of Light
43. Mirrors
44. Lenses
45. Refraction
46. Speed of Light
47. Near Sightedness
48. Far Sightedness
49. Colors of Objects
50. Steam Engine

TABLE I

Relative Values of Physics Objectives Assigned by Twenty-Five Teachers of Physics

Objective	Average Rank	Average Deviation	Range Highest	Range Lowest
A	8.4	2.5	1	12
B	5.5	3.1	1	10
C	4.6	1.9	1	11
D	4.8	1.9	2	11

E	3.7	2.7	1	10
F	6.3	2.5	1	12
G	3.7	2.2	1	11
H	7.1	2.1	2	11
I	10.7	1.5	4	12
J	5.3	2.4	1	11
K	8.5	1.7	2	12
L	9.4	2.1	2	12
AVERAGE	6.5	2.2	1.6	11.3

TABLE II

Per cent of Pupils Defining Each Physical Term Correctly and Indicating It as Useful

Number of Question	Per Cent Answered Correctly	Per Cent Who Said It Was Useful	Number of Question	Per Cent Answered Correctly	Per Cent Who Said It Was Useful
1	12.2	35.7	26	9.2	17.9
2	23.0	33.2	27	34.7	27.6
3	36.7	19.9	28	11.2	3.1
4	27.6	11.7	29	62.8	13.8
5	23.5	35.2	30	37.8	16.3
6	39.3	38.8	31	27.6	15.8
7	8.2	30.1	32	45.4	26.0
8	7.7	31.1	33	50.0	27.6
9	23.0	23.5	34	64.3	22.4
10	33.7	27.0	35	26.5	11.7
11	40.8	18.4	36	65.3	30.1
12	83.2	32.1	37	29.6	21.9
13	54.1	32.1	38	66.8	11.7
14	56.6	17.9	39	56.6	20.9
15	38.8	11.2	40	49.0	22.4
16	67.9	21.9	41	15.8	38.3
17	36.2	8.2	42	49.0	19.4
18	31.6	7.7	43	67.9	30.1
19	14.8	9.2	44	39.3	24.0
20	14.3	28.1	45	37.8	10.7
21	37.8	37.8	46	40.8	10.2
22	55.6	14.3	47	44.4	8.7
23	44.9	28.6	48	44.4	8.7
24	43.9	15.8	49	22.4	17.3
25	8.7	6.6	50	29.6	23.0

TABLE III

Distribution of Correct Answers in Relation to Number of Sciences Studied

Score or Number Correct	1–10	11–20	21–30	31–40	41–50	Total
Number of Persons	27	89	60	21	0	196
Average Number of Sciences Studied	3.6	3.1	2.9	3.0	0	3.1
Biology	3	4	4	8	0	19
Botany	9	14	6	0	0	29
Chemistry	23	64	32	9	0	128
Physics	27	88	60	21	0	196
Physical Geography	8	25	22	7	0	62
Physiology	12	33	13	5	0	63
General Science	15	50	37	14	0	116
Nature Study	0	0	0	0	0	0
Total	97	278	174	64	0	613
+	+	+	+	+	+	+

SUMMARY

The study seems to show the following:

It shows a lack of agreement among physics teachers as to objectives in teaching physics.

It shows—if accuracy is one of the things we aim at—we are falling far short of its attainment, for a large percentage of pupils gave wrong answers instead of omitting a question when they were not sure of its answer.

It shows pupils find the electrical work by far the most valuable.

It shows that a small proportion—less than ten per cent—would like more practical work in improving the course.

It also shows there is nothing very radically wrong with the course judging by the answers the pupils gave as to how it might be improved.

It also showed—and this will particularly interest physics teachers—a very general misuse of the word "Energy" as meaning "Force" and not as it is defined in our texts in physics as "the ability to do work."

The writer went in person to four of the ten High Schools to distribute the questionnaire for the committee and was everywhere accorded the most courteous treatment and a readiness to cooperate in every possible way. He wishes to take this opportunity to thank the High School Principals and their Teachers of Science for their generous and whole hearted help.

AIMS OF GENERAL SCIENCE AND THE PUPIL'S REACTIONS.

By HENRY P. HARLEY

Fairmount Junior High School, Cleveland, Ohio

The object of this study is to show the status of teaching aims of elementary science in the schools of Greater Cleveland, also, to check up on the achievement of pupils completing the course, as to grasp of subject matter, and to get from them their reaction to such questions as to the usefulness of the various parts of the subject matter; and their suggestions as to improving the course.

In response to the following questionnaire to teachers twenty-nine favored me with their consideration:

OBJECTIVES IN GENERAL SCIENCE

To the Teacher: Please rank the following objectives in order of importance by placing (1) before your first choice and (2) before your second choice. For example if you consider

the objective (c) first in importance, place "1" in the space for ranking before (c) and so on through the list. If you have other objectives for your subject please add them to the list.

Rank

..... (a) To acquaint the pupil with the interesting scientific phenomena of his everyday life.
..... (b) To help him appreciate the beauties of nature.
..... (c) To assist the pupil to comprehend in a measure the place of the earth in the universe.
..... (d) To give opportunity for training in handling with care and dispatch materials and apparatus.
..... (e) To emphasize neatness and good form in writing reports of readings and experiments.
..... (f) To help especially those pupils who leave before finishing high school to understand and appreciate in a general way the interesting phenomena underlying the processes of industry.
..... (g) To have the pupil respect and appreciate the life and work of great scientists of the present and of history.
..... (h) To train pupils in the process of clear thinking, and to assume a scientific attitude of mind.
..... (i) To teach the importance of skill in observation and investigation.
..... (j) To have him learn to suspend judgment until all facts are considered.
..... (k) To help the pupil find his aptitudes and interests in science study.
..... (l) To help pupils discern something of the opportunities and satisfaction of science study for future life.

The teachers were asked to rank these aims according to their importance. Two replied to the last request by submitting additional aims: First, to assist the pupil in acquiring definite knowledge where he may find information regarding scientific facts; second, to stimulate and maintain a keen interest in scientific knowledge for its own sake.

Table No. I shows the results of ranking of the objectives as to average rank, average deviation, and the range. For example, objective "a" had an average rank of 2.7; average deviation of 1.6; was ranked first by some teachers and as low as 6th by others.

TABLE I

Relative Value of General Science Objectives Assigned By Twenty-nine Teachers

Objective	Average Rank	Average Deviation	Range	
			Highest	Lowest
a	2.7	1.6	1	6
b	8.3	2.1	4	12
c	7.6	2.4	1	12
d	9.4	1.9	3	12
e	9.5	1.9	5	12
f	4.5	1.8	1	11
g	9.2	1.9	4	12

h	2.7	1.6	1	10
i	5.3	2.6	1	11
j	4.1	1.5	2	9
k	6.3	2.1	1	12
l	7.9	2.7	2	12

The twenty-nine teachers as a group consider objectives "a" and "h" first in importance. While the range for "h" extends from 1 to 10, just one teacher placed it in 10th place. If we eliminate this one case the range would be identical with "a;" from 1 to 6. The figures show these objectives on a par as to average rank and average deviation. After these, "j" stands second in importance. Objectives "g," "d" and "e" were considered of least importance, although two teachers ranked "g" as 4th; one ranked "d" as high as "3," and two ranked "e" as 5th. This table shows of course our teachers of elementary science are very much divided as to the various aims in their field.

The next part of our study deals with reactions on the part of pupils on the subject matter of the course. The pupil questionnaire which follows you will notice consists in part of fifty concepts covering generally the scientific material underlying our everyday life. They were asked to state in their own words what the terms mean to them.

Pupil Questionnaire

Note to Teacher: Please have questions below answered by 10th grade pupils, 10B if possible.

To be answered by the pupils. Time 2 (45 min.) periods.

(a) Please check below the sciences which you have studied. Biology..... Botany..... Chemistry..... Physics..... Physical Geography..... Physiology..... General Science..... Nature Study.....

(b) Place "u" before each term listed below which is useful to you in some way; in your play, work, reading, etc.

(c) What part of the General Science course is most valuable to you?

(d) How would you improve the course?

(e) State in your own words what each of the following terms mean to you:

1. Gas
2. Pressure
3. Wind
4. Cyclone
5. Compound
6. Element
7. Density
8. Evaporation
9. Condensation
10. Cloud
11. Rainfall
12. Temperature
13. Heat
14. Calorie
15. Humidity
26. Bacteria
27. Plants
28. Animals
29. Man
30. Energy
31. Force
32. Work
33. Machine
34. Friction
35. Lubrication
36. Fuels
37. Electricity
38. Current
39. Resistance
40. Electrolysis

16.	Solar System	41.	Battery
17.	Constellation	42.	Magnetism
18.	Rock	43.	Electromagnet
19.	Weathering	44.	Echo
20.	Soil	45.	Lens
21.	Fertilizer	46.	Rainbow
22.	Ground Water	47.	Reflection
23.	Drainage	48.	Refraction
24.	Irrigation	49.	Ventilation
25.	Soil Cultivation	50.	Health

Table No. II tabulates the results in the per cent of terms answered correctly, also, the per cent of the terms the pupils considered useful. The terms were answered correctly by more than 70% of the pupils in all cases except terms Nos. 7, 15, 17, 30, 31, 32, 35, 36, 40, 43, 47, and 48. In other words 76% of the terms were answered correctly by more than 70% of the pupils.

TABLE II

Per Cent of Pupils Defining Each Term in General Science Correctly and Indicating It Was Useful

Term	Per Cent Answered Correctly	Per Cent Who Said It Was Useful
1	79.0	72.0
2	85.0	50.0
3	91.3	65.8
4	74.4	18.0
5	77.9	46.3
6	78.3	54.3
7	69.0	34.8
8	89.6	59.6
9	73.3	41.3
10	83.1	48.8
11	92.9	72.8
12	92.0	68.5
13	77.4	75.3
14	73.6	58.0
15	67.1	40.8
16	84.5	45.3
17	60.0	24.5
18	83.1	54.3
19	76.0	44.3
20	86.4	73.8
21	92.1	59.8
22	80.7	41.5
23	88.3	54.8
24	94.0	52.3
25	86.1	59.5
26	85.5	47.8
27	81.0	64.5
28	85.0	63.8
29	83.9	60.0
30	68.2	62.8
31	65.2	55.3
32	66.3	64.3
33	78.7	63.8

34	76.0	46.3
35	61.4	48.3
36	65.9	65.8
37	75.5	70.3
38	73.0	53.0
39	88.3	40.5
40	44.2	29.3
41	76.9	55.8
42	77.7	46.3
43	57.3	37.6
44	77.4	32.3
45	72.5	50.0
46	76.3	38.0
47	69.2	46.0
48	39.6	29.0
49	84.2	64.8
50	82.0	70.5

368 Pupils

The low mark for the meaning of a constellation seems to indicate that the relation of the earth to the rest of the universe is not emphasized very strongly. The results of 30, 31 and 32 no doubt confirms the conviction of carelessness in our discrimination of fine shades of meaning. Terms 35, and 40 show low scores possibly for the reason that they are subjects somewhat difficult for 9th grade pupils although both abound in opportunities for revealing causes of familiar phenomena. The lowest score was on the meaning of refraction. The pupil comes into contact with this process so often in life that it would seem the subject should be emphasized to a greater extent than the figures indicate.

With respect to the usefulness of the various subjects, the table shows only 18% of the pupils considering the cyclone as useful, despite the fact that without cyclones moving across our state, Ohio would be a desert. This of course is due to the popular misconception of the term.

Table No. III was an attempt to show the background of the pupil as to science instruction. However such subjects as Biology, Physics and Chemistry were just begun to be studied as this questionnaire was answered by the pupils at the opening of the second semester of the school year 1923-24. The figures show moreover the tendency of the pupils making the highest scores in General Science to continue their studies in the special sciences.

TABLE III

Distribution of Correct Answers in Relation to Number of Sciences Studied

Score or Number Correct	1-10	11-20	21-30	31-40	41-50	Total
Number of pupils	1	12	50	114	191	368

Average number of science studied	1	1.2	1.4	1.6	1.8	.....
Biology	..	1	8	15	56	.....
Botany	..	....	....	.....	.....	.....
Chemistry	..	....	2	14	35	.....
Physics	..	....	2	2	8	.....
Physical Geography	..	2	22	46	63	.....
Physiology	..	....	3	8	9	.....
General Sciences	1	9	33	83	164	.....
Nature Study	..	2	2	15	13	.....

To the question "what part of the General Science course is most valuable to you?", one hundred eighty-five pupils responded with a variety of answers. Electricity stands first with a total of 55 or 30%. Next in order we have the relation of the earth to the rest of the universe, 21 pupils; plant life, 20 pupils; human body, 17; soil, 11; weather, 10. Below this list almost every subject of the course was mentioned by a few pupils.

Just about fifty per cent of the pupils offered suggestions for improving the course. Thirty-seven called for more experiments; ten asked for more electrical work; seven asked for more illustrations; six asked for more Chemistry; a few asked for assignments in magazines; a few for more time to one subject; some suggested the course be more practical; one or two recommended studying the lives of famous men. A number said the course is all right as it stands.

Summarizing: while the General Science teachers of Greater Cleveland are out of agreement as to the relative importance of the various aims of their course, they as a group consider as chief aims, to acquaint the pupil with the interesting scientific phenomena of his everyday life, and to train the pupil in the process of clear thinking.

Electricity and elementary astronomy are the chief interests of a large number of pupils.

The pupils request more experimental work and illustrative material to make the various subjects of the course clear and of practical value.

The answers to the meaning of the fifty terms reveal the fact that pupils entering the 10th grade possess a fair knowledge of the subject matter which they have studied.

General Conclusion

The facts brought out in this study indicate that in the organization of the curriculum more consideration should be given to sequence of the sciences. Furthermore, science teachers should be interested in the sciences rather than a specialized science only.

GEOMETRY IN THE JUNIOR HIGH SCHOOL[1].

By J. T. Johnson,

Chicago Normal College.

It is not within my power to tell what Geometry or how Geometry should be taught in the Junior High School. I shall, therefore, in this brief discussion, examine some of the criteria for determining what should go into a course of study, in this case, the Geometry of the Junior High School.

There are two criteria which determine a course of study—the social and the psychological criterion. The first deals mainly with the content; the second, with the place and method of teaching the subject matter.

These two criteria can be examined in more detail under the following outline:

I. The Social Criterion
   1. Expert opinion
   2. Contents of text books on the subject
   3. What will be needed by the student
      (a) In later life
      (b) In later courses in school.

II. The Psychological Criterion
   1. Place where subject should be taught
   2. Method with which subject should be taught.

Under expert opinion, I have tabulated the judgments of 24 members of the Chicago Men's Mathematics Club. On a questionnaire containing 125 terms, concepts, and truths from Geometry they were asked to indicate in which grade, 7th, 8th, 9th, or 10th, each item should be taught, also to indicate if any item should be omitted entirely.

These judgments form only a part of a larger investigation, hence only the summary of the judgments will be given here.

The total number of individual item judgments were distributed as follows:

omit	7th	8th	9th	10th grade
118	642	407	250	1028

The wide variation in grades show there is not definite agreement as to the best place to teach these concepts. 73 of the 125 items were marked to be omitted by 118 judgments. The heaviest vote in the 10th grade seems to indicate that much of Geometry should be retained in the 10th grade. This may be the result of habit and tradition, however, as well as anything else.

[1]Read before the Central Association of Science and Mathematics Teachers, November 29, 1924.

At any rate, it is only opinion, and opinion may be biased rightly or wrongly, how are we to tell?

Under the second criterion, the contents of texts, I have made a rather careful study of the 10 texts in Junior High School Mathematics now published. The result of this examination shows again opinion, but a little more careful and deliberate opinion based on more experience than that of the first criterion. Before anyone undertakes to write a text book, he or she takes some care in determining what should go into the text and what should not.

The result of this survey is found in the table.

Under Demonstrative Geometry the method of procedure was quite different in the various texts. Only three texts treated this topic.

In text no. 1 there were 25 pages of definitions, axioms and postulates preceding 117 pages of the regulation type of demonstrative geometry, including the 40 theorems generally found in Book I of Plane Geometry.

In text no. 3, 78 pages were given to about 50 propositions from Books I and II of Plane Geometry. Each demonstration, however, contained an analysis of the situation before the proof.

In text no. 5, 27 pages are devoted to demonstrative geometry-about 7 of the simpler propositions being taken up. The inter, esting feature here found was a brief history and explanation of logical reasoning preceding the formal theorems. Some space was given to logic and the syllogism.

In the next text, no. 6, the space is still more modest, reduced to 5 pages, and the title is changed to one of more subdued tone, intuitive geometry. Later than book 6 we find no demonstrative or intuitive geometry.

If we were to make a graph showing the historical decrease of Geometry and predict the future as is sometimes done, I am afraid demonstrative geometry is doomed for the Junior High School.

Explanation of Table

The texts examined are numbered from 1 to 10 in order of publication. No. 1 was published in 1917, no. 10 in 1924. Any subject matter of geometrical nature was listed under ten headings as shown, Trigonometry making the 11th. This naturally would include all material called mensuration in the old texts.

ANALYSIS OF SPACE DEVOTED TO GEOMETRY AND TRIGONOMETRY IN TEN STANDARD TEXTS IN JUNIOR HIGH SCHOOL MATHEMATICS.

No.	1	2	3	4	5	6	7	8	9	10	Tot
Grades	7 8 9	7 8 9	7 8 9	7 8 9	7 8 9	7 8 9	7 8 9	7 8 9	7 8 9	7 8 9	
Lines and Angles	2	30	16 19	6 10	4 3 2	24 2	6 15 4 4	7 16	13	12 10 6	213
Plane Fig's. Areas	8 35 2	12 10	2 8 20	7 3	11 23 30	9 40 2 1	18 6 2	6	8 9 2 1	8 27 32	342
Circles	4	3	2	2 3	8	11	1 7 5	8	11	9 4	78
11s Cut by Trans.		4	2		10				1		17
Similar Tri-angles	8 11	9 6 4 1 4	15	12	19	5	16 1	12	7		130
Vol. & Sur-faces	2 7 2	10	25 2	1 28	3 7 7	14 6 2	20	22	10	23	191
Con-struc-tions	14 2	4 13	11 1	12	10	9	11 9	17	5		118
Scale Draw-ing	6 6	3 10 1	2 1	2		4	7	6			48
Demon-strative Geom.	25 117		78		27						247
Intui-tive Geom.						5					5
Trigo-nom-etry	22	5 12 1	8		24	9	24 11	2			118
Total of Pages	114 164	13–61 68	84–86 42	71–15	139 51	90–38 15	92–45 30	54–42	50–17	66 65	
	278	142	212	86	190	143	167	96	67	131	
Pages in each Book	250 250 282	210 212 240	206 246 227	229 237 235	219 236 243	224 255 343	256 254 382	244 276	196 237	228 251	
Gr. Tot..	782	662	679	701	698	822	892	520	433	479	
% of pp on Geom & Trig.	33 35	18 22	30 31	12 12	23 27	15 16	14 18	18 18.5	15 15	27 27	

Each series of texts comprises three books for each of the grades 7, 8, and 9. The last three series include 2 books each only as the third book was still in press at time of this survey.

The figures in the body of the table denote pages devoted to the various topics in the different grades throughout the ten texts. The three rows of pages under each topic in each grade denote the part of the book from which the pages were found.

The table should be read as follows:

In text no. 1 "lines and angles" were treated in the middle part of grade 7, 2 pages being devoted to them. In text no. 2 "constructions" were dealt with in middle part of grade 7 in 13 pages and also in first part of grade 9, 4 pages. In text no. 5 the space given to "plane figures and areas" was scattered throughout the book for 8th grade, 11 pages in first part, 23 in second part and 30 in last part.

The percentages in the last two rows were based on the total pages of geometry material in ratio to the total pages in the text. For example, in text no. 1, 278 is 35% of 782.

One notes a rather interesting shifting of figures from grade to grade. In text no. 1 the geometry was mainly in the 7th grade. In no. 2 it was moved to the 8th and 9th grades. In no. 3 it went back to grade 8. In no. 4, farther back to grade 7 again. In text 5 it started back to grade 8 again. Since then it has been scattered throughout the grades with the greater amount in the 7th grade.

Contrary to current belief, perhaps, the geometry material has been growing less and less as a general tendency as shown by the percentages. In a later text, not included in this survey, as but first part of grade 7 is out, four-fifths of space is devoted to geometric material.

The third criterion, first part, what use is made in later life of Geometry, cannot be used exclusively by the Junior High School, as Geometry will be taught in the Senior High School if not in the Junior. Our question is, should it be taught in the Junior High School and how much of it?

On this criterion there have been some investigations. One, that of Mr. Davis, was conducted some years ago on the value of mathematics to the citizen outside of school. You are, no doubt, familiar with it. The result of this questionnaire was decidedly in favor of mathematics for the boy and girl in High School. It was what might be called public opinion and should be given its due weight.

On the second part of the third criterion, that of use in later courses in mathematics, we should place more emphasis, for more students go to High School now than two decades ago. Mathematics will be taught in the Senior High School and perhaps one year of it will be required in most High Schools for a generation or two to come. If the Junior High School can clarify some of the concepts and terms used in later geometry and give the student familiarity with the figures to be used later why not teach some of these topics there? But to be fair, this question arises. Perhaps these concepts can be taught better and more quickly later in the Senior High School in connection with demonstrative geometry itself. This question it is the function of the psychological criterion to decide. Before we take up that criterion, let us evaluate each of the minor topics in table II in light of criterion 3. For proper examination of this criterion we should have results from an extensive questionnaire. We can answer one part of it and much of the other without the questionnaire, however.

We can defend lines and angles both from use in later life and in later courses.

Plane figures and areas occur in quite common and general experiences outside of school and of course in later courses.

Circles, likewise.

Parallels cut by a transversal, in later courses but not in later life. Shall we retain this topic in the Junior High?

Similar triangles, in later courses but not in later life.

Solids, we should say in both.

Constructions. How about them? Not in later life. Do we use them in later courses? Do we construct perpendiculars, parallels, etc., Do we use them in connection with the Theorems of Geometry? Do we use them in Mechanical Drawing? Physics? Chemistry? Engineering? Do not the right triangle and T square serve the purpose better here and are they not in fact used rather than the long and comparatively inaccurate method of construction by means of compasses? When the engineer bisects an angle, does he not use some form of a scaled protractor? Perhaps we can defend them on the ground of mental discipline. May we have discussion on this point later.

We come next to scale drawing. This topic, I think, can be defended both on basis of use in later life and in later courses. For ability in reading maps, building and room plans, and graphs in general literature now found in magazines and newspapers it is needed.

All of these topics with the exception perhaps of constructions, even if they do not fulfil both parts of this criterion furnish interesting and useful applications for Arithmetic and Algebra and should be retained in the Junior High School course.

There now remain the two vital questions as yet unanswered. They are: (1) Should Demonstrative Geometry and Trigonometry be taught in the Junior High School? (2) In which grade should these other topics just enumerated be introduced, in the 7th, 8th, or 9th grade?

The answer to this question, which is the psychological criterion, can only be found through some set and carefully supervised experiment. I know of no such investigation at this time. Would it not be possible and highly profitable to carry on such an experiment in some of our Junior High Schools or in some of the University High Schools which are experimental in nature? Let this suggest one line of action. Take two groups, whose median I. Q's are about equal, one group from the 7th or 8th grade, the other from the 10th or 11th grade. Give them the same training from the same text and same instructor for the same length of time. During the progress of the experiment note the interests of each group and from time to time give tests and note the progress made. At the end of the course give the same comprehensive test to the two groups and make comparisons. A year later give another test to both groups to learn how much each has retained. Comparisons of results of several sets of these experiments from more than one set of schools could then be made and legitimate conclusions drawn as to where interest and economy is greatest in teaching any of these topics. Similar experiments could be carried on within the Junior High School on any of the minor topics upon which there is most disagreement.

Various methods of teaching, say, demonstrative geometry could be similarly tested. It would be fruitful to know whether the Euclidian method, the laboratory method, the logical method or the intuitional method would yield the best results. Not only would Geometry teaching be more valuable to the generation which follows us but it would be a keen joy to the live teachers of to-day. We are to-day following two extremes. Some are following the rut laid out by tradition and the rest are following the fads and fancies of text book writers just to be up to date. The true course may be between the two. It is possible now that the method of teaching geometry and the place of teaching

it can be placed on a scientific basis for we have the tools and technique wherewith to do it.

Now, in conclusion, while these experiments are getting under way, what shall be done with demonstrative geometry and trigonometry in the Junior High School? May I give two reasons why I think they should not be taught in the Junior High School? (1) Pupils coming from the grades are very deficient in the fundamental operation of arithmetic, the use of the decimal point and the common uses of percentage. It therefore seems wrong to crowd geometry and trigonometry down into these grades when they can, no doubt, be taught better to more mature minds. (2) If we introduce these advanced topics such as demonstrative geometry, trigonometry and the function idea into grades 7, 8 , and 9 are we not taking away a great deal of the interest and thrill from the student who later takes them up with the expectancy of taking up a brand new subject for the first time with the attendant wonder which a normal mind experiences when embarking upon a novel und unknown field? Again if the subject has been presented poorly or not as well as it would have been in the Senior High School there is danger of interest being lost to the student when he takes up the same subject again later.

Why not organize a committee or two for research along these lines?

COSTS ENGLISHMEN NOTHING TO BECOME DENTISTS.

Maintenance allowances, instruments, books, and fees are provided for qualified persons in the United Kingdom who wish to study dentistry and lack personal means of doing so. This statement was made recently at the seventh session of the dental board of the United Kingdom by F. D. Acland, the chairman.

There is, he said, probably no other profession in the country into which a student qualified to take advantage of professional training may obtain entry practically without cost to himself.—*School Life.*

WISCONSIN UNIVERSITY INSTRUCTS HOUSEWIVES IN DECORATION.

Day schools in house decoration for housewives were recently conducted by the University of Wisconsin extension division in five cities. The lessons consisted of talks and lantern slides on interior decoration. By the use of material and demonstrations in arrangement of rooms an attempt was made to show women the possibilities that exist in the careful use of the things they already have in their homes. The schools are continued for a week in each city. They will be continued on the same plan in other cities until the middle of the winter.–*School Life.*

LECTURE—DEMONSTRATION—RECITATION TECHNIQUE IN BIOLOGY TEACHING.

By Jerome Isenbarger,

Crane Junior College, Chicago, Ill.

Results of carefully prepared tests have demonstrated that, in so far as fact-getting is concerned, lecture-demonstration methods of biology instruction are superior to laboratory methods. Taking this fact on its face value incurs dangers that need to be pointed out, especially to the young teacher. These dangers emphasize the necessity for a recognition of the definite aims of teaching in biology and of the steps that must be taken by the student in realizing these ends of education. Then should follow the employment of a technique devised to accomplish a specific purpose.

The devotion to the laboratory has, at times, assumed the proportions of a fetich. Faulty pedagogy in connection with insistence upon a certain kind and definite amount of laboratory work has retarded the acceptance of biology in the high school and probably, to some extent, in the college as well. Several misapprehensions of the functions of the laboratory may be pointed out. 1. That the chief facts of a science should be rediscovered in the laboratory. 2. Feeling that the scientific method consists in the observation and recording of facts. 3. Slavish dependence upon outlines and manuals as true laboratory procedure.

The importance of the laboratory in training in science must not be under-estimated. A rational perspective should be set up in order that we may properly evaluate laboratory practice in any given situation. Much time is wasted in the use of the compound microscope in high school classes. The proper use of the projection microscope recommends that instrument highly for the biology work in any grade of school. The laboratory, however, has functions which are clearly and exclusively within its own field as a medium of instruction and training. True functions of the laboratory may be stated as follows: 1. To make clear facts that are not easily visualized without concrete individual demonstration. 2. To give skill and accuracy. 3. To give an appreciation of the scientific method. 4. To get pupils to think. The laboratory method is the method of research. It is the slowest possible way of getting facts. For this reason, where information is the main objective, the lecture-demonstration-recitation method, being more economical,

and at the same time more effective, should be the chief means used.

The excessive use of the lecture method has been the target for criticism for centuries. Socrates warned against its dangers. A number of valid objections can be filed against this method, even as it is used freely in the colleges to-day. Aside from the pernicious effect which results from a slavish devotion to this method, directly, the high schools suffer, as an indirect result, from the effects of similar methods used in these schools by teachers, just out of college, who, consciously or unconsciously, imitate their college teachers. Quoting from Dr. T. W. Galloway, "In my opinion, the most effective teaching of biology to-day is being done in the best high schools by teachers who have been forced to acquire a pedagogical background that would enable them to reconstruct completely their presentation of the subject. Most of these people received very little help in this task from their college courses in biology. For this reason every college teacher will profit by what has been written by the secondary teachers." The notion which is quite prevalent that scholarship is the only prerequisite to successful teaching, has done much harm. Says Paul Clapper under the heading, "Professional training for college teachers," "We consider the Ph. D. a scholar's degree and not a teacher's degree," says the dean of one of our leading graduate schools. He (the teacher) needs to know the learning process. He needs to know the different methods and aims in the teaching of his subject and, so far as possible, the results attained by each. Too much of the college teaching is blind, groping, chartless and without compass. Instead of expecting each inexperienced teacher to start afresh, he should be set out armed with the epitomized and digested teaching experience of those who have gone before him."

The term, "lecture-demonstration-recitation" has been chosen purposely to call attention to a method of procedure which presupposes in the teacher a knowledge of subject-matter and specific aims, a recognition of mental equipment and thought processes of the pupil and the employment of a technique particularly suited to the solution of the problem at hand. The teacher's method should be sufficiently flexible and ingenious to avoid the defects which call forth the valid criticisms of the lecture method. It should encourage pupil activity. Subject-matter should be presented in such a way as to leave permanent impressions. The instructor should, at any time, be able to test the accuracy of the student's conceptions and to judge the efficiency of his

own methods. This calls for contact between pupil and teacher.

Efficient technique demands a plan, organized about a main purpose, for every class exercise. This requires selection in advance of subject-matter to be presented, illustrative material to be used and, in general, the questions that are to be asked to determine the student's reaction.

As a source of illustrative material, I have found the projection lantern, with specially selected slides, made-to-order slides and home-made slides, almost limitless in possibilities offered. Ordinarily, it is cheaper to buy slides of a reliable slide-maker than to make them. Diagrams and charts made by students may be photographed and the lantern slide positive plate made from the camera negative. In the same way, diagrams and pictures from books may be copied on lantern slides and made a part of the permanent equipment of the department. Photograph negatives of illustrative views from the field may be used directly in making lantern slide positives. A camera using 4″ x 5″ plates or films should be a part of the equipment of every biological department. If copying is to be done, an additional long-bellows camera will be needed for dark-room use.

Modern projection equipment makes it possible for the instructor to operate his own lantern while in a convenient location for speaking. There are two methods of projection of this sort which recommend themselves from the fact that the room need not be darkened. If the medium-sized lecture room is approximately square, an ordinary projection curtain may be placed across the darker front corner of the room and the lantern near the middle of the opposite side. A small metal pointer may be used on the front side of the slide. I use a 1,000 watt mazda lamp with resistance, with a combined opaque and slide projector. It is not necessary to draw the shades unless the opaque projector is used.

The translucent screen offers a second and superior means of daylight projection. Any lantern can be equipped with a projection lens of 4⅛″ focue together with a suitable condensing system at small cost for this class of projection. An excellent translucent screen may be made of tracing cloth coated with paraffine, on both sides. The paraffine is melted and xylol is added to prevent immediate hardening upon cooling. A thin coat is applied with a brush. As the xylol evaporates, the surplus of wax should be wiped off with a soft cloth. If necessary, use some xylol on the cloth used for wiping. The screen may be

bound by sewing on one inch cotton braid. It may be fastened to a frame by means of ¾″ snap fasteners. It should be remembered that water will ruin tracing cloth.

The natural psychological process requires that a new topic be presented first as a vague whole. Then should come an analysis, a separation into its parts and a definition of details. Then finally there should be a synthesis consisting of a bringing together of component parts and related details in such a manner as to make clear the relationships of parts to the whole.

With a lantern which can be turned on or off without any attendant fuss of manipulating window shades or directing an assistant, suitable diagrams, photographs or drawings may be thrown on the screen for general impressions, then these can be brought back later for details and summary.

Microscopic detail can be best shown, in so far as class demonstration is concerned by means of slides made from microphotographs. The proper use for the high power projection microscope is in a dark room where small groups may be taken for special demonstration.

Technique of asking questions calls for skill in setting up situations for questions as well as in questioning. The development method is here called into use. There is contact with the student. The teacher sees the results of his teaching and the student is trained in habits of systematic thinking and concentration.

The traditional examination for testing the results of instruction, being a test for what is temporary and accidental, is not a safe criterion, in itself, by which to judge the progress student. Rating should be on the basis of socially useful knowledge acquired and power gained. The latter is indicated by the facility with which a student is able to interpret situations and solve problems. I have been using a system in my classes which has proven helpful to me as well as to the student. As the course progresses, mimeographed sheets of questions, prepared according to the development method, are given out and used as a basis for quiz periods. They are also used as a basis for all of the written tests of the term. At any time in the term the student has not only a complete record of work covered but also a record of the method by which the different topics were developed. The practice may be open to criticism, but as a device, it has many good points in its favor.

It seems obvious that no one method should be used to the exclusion of other methods of instruction. Effective technique employs different methods. It recognizes the aims of the course and the mental maturity and thought processes of the student and uses such methods as are best suited to bring about the desired results.

DIPHTHERIA DANGER HIGH IN ISOLATED COMMUNITIES.

Isolated communities such as Nome are in particular danger from epidemics of diphtheria, not only because medical supplies may be far off and hard to get, as in the present instance, but also because isolated populations apparently tend to become more susceptible than those in thickly settled regions. Dr. J. A. Doull, of the Johns Hopkins School of Hygiene and Public Health, points out certain peculiarities in the behavior of the disease that makes it an especial menace to lonely places.

As everybody knows, diphtheria is peculiarily a disease of children, Dr. Doull says. Its greatest incidence is among children three years old. After that age the number of children contracting the disease fall off rapidly; there seems to be a gradual upbuilding of immunity, beginning very early in life. Little is known of the means by which this immunity is acquired, but apparently we are always getting slight infections, and by throwing them off we store up enough natural antitoxin in our own blood to prevent a serious attack.

These slight infections are kept in circulation in settled regions, for there are always diphtheria "carriers" about; but in isolated places they may never occur at all, and the opportunity for building natural resistance will be correspondingly absent. Then when a really serious infection is introduced it spreads rapidly among a highly susceptible population.

Dr. Doull cites a case somewhat analogous to that of Nome, which was studied by Dr. A. J. Metcalfe, an Australian physician, only a year or so ago. Off the north coast of Australia, in the Torres strait, there is a bit of land called Thursday Island. The population is largely a mixture of Malays and Asiatics, with surviving native elements. Dr. Metcalfe used the Schick test on a large number of children in the schools, ranging between the ages of six and fifteen, and found that nearly 97 per-cent of them were susceptible to diphtheria. With this nearly complete susceptibility Dr. Doull contrasts the figures obtained in Baltimore, which has been more thoroughly surveyed for diphtheria statistics than any other city in the United States. Here 93 per cent of the children one year of age were shown to be susceptible; but at six years the susceptibility had fallen off to 69 per cent, and at fifteen to 27 per cent. Figures for thes emi-isolated conditions of rural life in America stand intermediate between those for crowded cities and thoso for this highly isolated island.

Another fact mentioned by Dr. Doull which supports this apparent relation between crowding of populations and the development of immunity to diphtheria is the high rate of natural immunity found in asylums and similar institutions for the care of children.

A further suggestion developed in the discussion was the possibility of the development of an especially virulent type of the disease in isolated and highly susceptible communities, which might be more dangerous and difficult to combat if brought back to more thickly settled communities. It is a well known fact that a strain of disease germs gains in virulence upon being "put through" several successive non-immune persons or animals, and this suggests a possible danger from the present Nome epidemic.

THE PROBLEM OF SEX EDUCATION.

By Chas. W. Hargitt,
Department of Zoology, Syracuse University, Syracuse, N. Y.

Social phenomena of many sorts, some of remote, and some of very recent origin, have become convergent within recent years to a degree which at times became a veritable hysteria of apprehension. Conspicuous examples of this may be noted as follows. The divorce evil, the social evil—that ancient evil awakening under a new conscience—race suicide, race degeneracy and so forth. Correlated with these are the menace and economic loss involved in preventable diseases, such as feeble-mindedness, degeneracy, insanity and their train of human woes. To render still more ominous the portent, new light on the part of heredity as related to these ills has brought the whole within the field of possible control or direction. Serious as these may be there is no real occasion for hysteria, but surely there is an imperative demand for the most sane and critical consideration of the serious problems which are involved. And to no class of persons is this more imperative than to us whose daily work brings us into direct relation with one of the first lines of duty and opportunity, namely, that of education.

In an address before the New York State Teachers' Association some years since, and again in a paper prepared for a conference on sex education at Rochester, New York, under the auspices of the National Public Health Service, the writer deliberately chose the phrase sex education as a better expression of the real and fundamental problem than the then more prevalent phrase "Sex hygiene" or "Social hygiene." And it is a satisfaction that this conception has likewise been shared by many others as well. As a reason given at that time the following sentence or two, quoted from the above mentioned address, may be pertinent: "Our first duty is to focus attention upon a first need,—education. It is well known that much of the most serious of the evils concerned is due to ignorance, *innocent ignorance*, of functions most vital and sacred. The phase of this education for which I would plead most earnestly is that concerned with the better appreciation of the fundamental nature of sex in general, and the implications of human sex in particular, and the significance of the sex function as it relates to all life."

Every student of biology knows well that in the natural living world sex is not a problem. It is self regulative under the

rigorous law of struggle, adaptation and survival. In other words, it is part and parcel of the laws involved in the evolution of life. It is only when life is given certain metes and bounds under artificial or conventional conditions, that sex introduces problems and perplexities of serious import. Such are those of domestication, and human and social conventions under highly artificial circumstances involved. Let it not be implied that these are *new* problems. Far from it; they were old problems even in Plato's day, and his Utopia was a proposed attempt to solve some of these perplexities. From the earliest expressions of social evolution among mankind up to the present there have been gropings, crude experimentation, ethical and religious interventions. It is not too much to believe that under our later and larger knowledge we have now at command larger resources, and have, also, acquired through experience better modes of approach and methods of presentation.

(*A*) *The Nursery.*

Sex education should begin in childhood, with parents as teachers. Even allowing that most parents are technically poorly qualified for the serious job, still they may readily learn certain principles of sanitation, hygienic cleanliness, their imperative importance in relation to sex organs and functions, with the nursery, toilet and bathroom as the school, and the operations involved and their meaning made clear to boys and girls together, where parents in their own ablutions may inculcate indelible and pure lessons of sex distinctions. If this duty be evaded as a joint operation, then may not father with boy, mother with girl discharge as a sacred duty these obligations during the early years of innocence, when the sex consciousness will in no wise complicate the problem.

(*B*) *The Elementary School.*

In the period of elementary or grade-school life there is no better mode of approach than through nature study, or very simple biologic courses of similar scope. Let it go without question that all such education must proceed upon biologic principles, it matters not through what direct avenues it may be presented.

Here the processes are simple; they are natural; they follow sound pedagogic methods; the lessons are stimulating; interest compelling and involve an approach to the subject of sex in a way not likely to appeal to the morbid or sensual emotions.

During forty years of teaching experience, including young

people varying from early adolescent years on to mature men and women in upper years of college, and in mixed classes, this mode of approach has never involved sinister or vulgar attitudes, but almost without exception the deepest sense of the profoundly physiological and hygienic basis of sex, and leads on to the appreciation of its ethical and sociological values.

With the groundwork provided by such grade work the next step, and in my judgment the most difficult and serious step, is that of

(*C*) *The High School.*

Here we are in the physical and psychical period of emotional instability,—in other words, the adolescent. Under the most favorable auspices possible the problem is most difficult and serious. If the grade work above considered has been intelligently done, if pupils have had adequate introduction through elementary biology or good nature work, then there will be less apprehension as to the mode of approach to problems of sex without the danger of making such instruction directly and conspicuously sensational as "sex hygiene," as has often been done, with serious consequences.

As already intimated, I am firmly convinced both from experience and observation that unless sex education may be conducted without provoking and stimulating morbid or mere vulgar curiosity, its results are likely to be serious and harmful. Hence, to have a special teacher for that subject alone, and he or she operating as an occasional teacher, or still worse to have it given by a medical man is to still further complicate and aggravate the danger.

(*D*) *The College.*

For the college the problem is less difficult. Where there has been some fundamental work done already, either in the grade, or high school, based upon elementary biology it may be assumed that the college may proceed upon such. Yet in my own experience this assumption is not generally warranted. While many students will have such needed preparation, many others will not have had. The schools where adequate work in either grade or high school has been successfully done are comparatively few. For example, even in New York City schools I have the impression that much is lacking. In my own work, now under way for many years, I require that the course in general biology be a prerequisite. And even with that restriction the course is frequently over crowded. Hence, I seriously

doubt the practicability of making college courses in genetics or eugenics required of all students. I freely admit the desirability of requiring such courses, but the problem would involve difficulties which would approach the prohibitive point.

And after conferences with departments of physiology and sociology, it would seem that probably a department of sanitation and public health, if grounded in sound biology, would afford the best administrative and coordinated plan for carrying out the consensus of opinion expressed in the former section, and in my own mind approved by subsequent study of the matter. If any plan be feasible for reaching the largest possible body of college students in the critical educative insight to our problem, I believe some such plan must be organized. So far as I am aware, this has not as yet been done by the college, though well aware that many have provided for such instruction, but as elective courses rather than required. When one for a moment considers fifteen to eighteen hundred students in the academic college alone, and aggregates in a university of five to ten thousand students, the problem of bringing such numbers under any such course as the one contemplated is fairly appalling.

As a final word under this head may I drop a suggestion, namely, even in leading colleges where hygiene has been made a required course for freshmen, both men and women, it is not unusual to have it vulgarly designated as "smut" course I or II! This as a mere incident may not be without value to us as to the way in which some minds may react under these required courses. Is it not worth while that we recognize, even tentatively, the lurking danger to be faced? True, it may be less serious than that other danger involved in the attitude of *laissez faire*, or doing nothing, may beget. But while facing the former and recognizing its danger, it would seem that it were of less peril than that involved in the latter.

As a further suggestion I am constrained to submit as a possible phase of our subject the provision which in many larger colleges and universities is provided for. In these it is understood that many following their college course will enter upon the medical course, and the medical colleges are now requiring of all cadidates two years of preliminary college work as aa condition of admission. My proposition is this, that within these two years of premedical preparatory work there be required a course in genetics or eugenics. Already there is re-

quired a year of work in zoology or biology, which is just what would have fitted the student to take up the course in genetics or eugenics effectively. This will have grounded him in biological principles, and so have fitted him to properly appreciate the technical aspects involved in his profession course. It is especially desirable that the medical schools provide such instruction, and that it comprise a well studied purpose to have it clearly grasped in its social and ethical implications. From personal connection with medical education in former years, and in the conduct of final examinations of students, it was rather obvious that in many cases there was little clear appreciation of the fundamental biological basis of sex, or of its sacredness under those laws of life against which infractions are no less serious than violations of other laws of health too well understood to call for special mention. Every physician is well aware of these facts, and some insight on the part of the medical student during his course can hardly be open to question as a part of his preparation to meet intelligently those obligations involved in the ethical code of his profession.

Again such a training would fit the outgoing physician to be the most intimate and helpful adviser of parents as to problems of the home, and instruction of children in the subjects under consideration. It seems to me that no finer means of getting efficient sex education into the home could possibly be devised than that here proposed. While it need not in any wise lessen the importance of such as is contemplated in the earlier sections of this paper, it would still afford an efficient and authoritative accessory in reaching the center of primary importance—*the home*.

NEW EXPERIMENTS IN LIGHT AT THE UNIVERSITY OF CHICAGO.

For generations physicists have been finding increased support for the so-called "wave theory" of light, upon which rests the basic work involved in immense practical operations like X-ray work of all kinds and radio transmission. More recently, however, the theory of so-called "radiation quanta," which is, roughly, a revival of Newton's old view that light consists of minute streams of particles, has been gaining ground, according to Professor Arthur H. Compton, of the University of Chicago, who is a specialist in the investigation of X-rays.

Professor Compton has reported on experiments which, he says, "agree very nicely with the predictions of the quantum theory, and are difficult to reconcile with the wave theory." When asked if it was likely that the scientific world would return to Newton's old idea of light particles, Dr. Compton replied that recent effects have been very puzzling, but that it is hoped the final solution will be one which will somehow reconcile the wave theory and the quantum theory.

TEACHING TEMPERATURE EFFECTS TO ELEMENTARY STUDENTS.

By R. A. Baker,

Professor of Inorganic Chemistry, Syracuse University, Syracuse, N. Y.

The plan of emphasizing very early in the first course the effect of a change in temperature upon the rate of chemical action has invariably proved to be well worth while.

Recently, in preparation for this topic, five hundred students were asked to report changes of any nature in which there seemed to be some relation between the temperature and the speed with which the change took place. They were urged to select from as wide a range as possible and were not required to give quantitative data. Since most of these students had had no previous training in chemistry, many examples were given which are usually classed as physical—particularly those associated with changes of state—but plenty of "orthodox" material was included. It is evident that the average freshman already possesses a considerable fund of knowledge on this subject—facts which can be very substantially woven into his chemistry course.

Assuming that the result of this survey would be of interest to others, I have prepared a list of representative examples, from which there have been deleted those obviously given by students with a knowledge of chemistry.

Nearly all called attention to the increased rate of evaporation of liquids—(1) the direct effect of the sun's heat or warm air on systems containing water, such as the drying and withering of vegetables, the parching of the ground, the drying of linen, lumber, pottery, the skin, etc., (2) artificial heat in the drying of dishes, lumber, hair and linen; in the manufacture of salt from brine and maple sugar from sap, and in ironing clothes.

The rate of solution, while confused with the extent of solution, or solubility, found illustration in the dissolving of salt, sugar and soap in hot and cold water, respectively, the brewing of tea and coffee, the use of hot water in laundry practice and the action of varnish remover in hot and cold weather, respectively.

In one way or another all referred to the effect of a rise in temperature on changes associated with plants and animals. The rate of growth of plants in the tropics was frequently contrasted with that in the arctic regions, while each of the follow-

ing appeared in many lists: the swelling of buds, the germination of seeds, the ripening of fruits and tobacco, the curing of hay, the appearance of blackheart in potatoes, the rusting of lettuce, the rotting of apples, the production of wine and vinegar, the decomposition of compost, the spoilage of milk, meat, eggs, etc. The reciprocal effect of refrigeration was also described, one student calling attention to the fact that the flesh of prehistoric animals is still edible after having been preserved in the icefields of the north. Many drew attention to the increased rate of combustion in the human body in the case of fever. The rate of cooking foods was also mentioned, as in coagulating egg albumen, browning toast, etc. One observant youth said he had noticed that lobsters turn red much more quickly in very hot water, and added that a blister produced by hot taffy or grease forms more rapidly than one produced by hot water. Another drew attention to the fact that flies move more slowly in cold weather; that crickets chirp more frequently in warm weather and added that he was almost positive his father's whiskers grew more rapidly in hot weather than in the winter.

A considerable number of students had noticed that a match will strike more readily in a hot than on a cold surface; that iron rusts more quickly in hot weather than in cold; that wood and coal will burn most quickly in a very hot fire; that paint dries best in warm weather; that photographic films and paper develop more rapidly in hot developer solution. Those who had had experience with cement and plaster had observed that the speed of setting is dependent upon the temperature. About twenty five per cent correctly interpreted the spontaneous combustion of green hay and of oily rags or coal. One boy was unshaken in his statement that his shot gun did not have as great a range in winter as in summer.

It is perhaps needless to add that, after this preliminary report, the class as a whole was eager to discover more concerning this interesting principle. The following simple qualitative experiment is recommended for introduction at this point: Approximately equal weights (10 grms. are sufficient) of Ammonium Chloride and Sodium Nitrite are placed in the bottom of a 500 cc. Erlenmeyer flask and covered with water. Then, while supported with a test tube holder, the flask is cautiously heated over a free flame, with constant shaking.

$$NH_4Cl(w) + NaNO_2(w) \longrightarrow NH_4NO_2(w) + NaCl(w) \quad (1)$$

$$NH_4NO_2(w) \longrightarrow 2H_2O + \overline{N}_2 + \Delta \quad (2)$$

As soon as bubbles of $\overline{N}_2$ are apparent, the flask is removed from the flame but the shaking is continued. Since the decomposition of the NH_4NO_2 is exothermic, while the loss of heat from the system is comparatively slow, the temperature rises. With increased temperature the rate of this decomposition increases until, after a very few seconds, the liquid froths out of the mouth of the tube and large volumes of steam are generated. If the flask is now immersed in cold water the action subsides, but will speed up again when the flask is removed. This alternation, without external heating, may be continued until the material in the flask is practically exhausted.

This experiment has the advantage of being simple; of being plastic in the hands of the student and of lasting over several minutes while the student has an opportunity to orient himself. It does not of course indicate that a rise of 10° approximately doubles the speed of the action. This quantitative relationship may be shown very nicely by employing the reaction between $KBrO_3$ and HI in the presence of starch solution. which has been described elsewhere.[1]

FINANCIAL ADVICE OFFERED GRATUITIOUSLY TO TEACHERS

Competent advice on personal financial problems, offered gratuitously to teachers and other employes of the schools of Highland Park, Mich., is reported by H. C. Daley in *School Life*, a publication of the Department of the Interior, Bureau of Education. A standing committee has been appointed, consisting principally of successful business men, most of whom are members of the board of education. To this committee may be brought any financial perplexities in which experienced business men may be presumed to be able to offer advice. The service will not necessarily be confined to investment problems. The committee will also pass upon applications for permission to distribute circulars and other printed matter through the schools.

HIGH SCHOOL GIRLS INSTRUCTED IN CHILD CARE.

A nursery school is operated in connection with the public-school system of Highland Park, Mich. It accommodates 15 children from 2½ to 4½ years old. A full-time housekeeper is employed, a school nurse makes daily visits, and the work is under the supervison of a trained household arts instructor. Uppergrade high-school girls in relays assist in the care of the children, and 120 each week will receive the benefits of the nursery as a laboratory.

Food for the children is prepared in the school kitchen. Copies of the menus, with special food suggestions, are sent to the mothers. A normal life is led in the nursery, the children being allowed to work, play, or sleep as they desire, and in a surprisingly short time they become self-reliant and thoughtful of others. While the nursery is of real value to the children and the mothers, its main purpose is to give practical training in child care to high-school girls of the upper grades.

[1] Noyes and Blanchard, J. Am. Chem. Soc., 22. 742 (1900)

COTTON ACQUIRES A NEW CAMOUFLAGE.

By Dr. Edwin E. Slosson.

Cotton is a social climber. Handicapped by its lack of the sheen of silk or the luster of linen or the warmth of wool, it is now gaining upon its rivals by aid of the chemist.

Silk, the aristocrat of textiles, gets the gloss that is the envy of thf rival fibers from being forced out in a viscous from the tiny orifices o the spinnerets of the silkworm, solidifying as a single slick smotth cylinder a thousand yards long.

Cotton, on the contrary, if you compare it under a microscope, looks like a short twisted tape, and wool like a rough and scaly rope. Cotton, to quote an old joke, shrinks from soaping—like a small boy, Dipping cotton into strong alkali causes the fibers to shorten and thicken and soften. Seventy-five years ago it occured to an English chemist, John Mercer, to try what would happen if the cotton were not allowed to shrink. So he kept the thread or cloth on stretchers while it was dipped into a solution of caustic soda and left to dry under tension. The lye took the kinks out of the cotton and softened its surface and this gave it something of the luster of silk. So Mercer immortalized himself, like J. L. MacAdam, the road-maker, by converting his name from a proper noun to a verb, and we have had "mercerized" cotton ever since.

Now a new method of treating cotton has been invented. This is the opposite of the mercerization process for it is produced by acid instead of alkali. Charles Schwartz of the Philana Company at Basle, Switzerland, has found that cotton may be made to resemble its other rival, wool, by immersing it in concentrated nitric acid. The fibers become more curly and their surface rougher, and the fabric assumes the texture of a new material to sight and touch. The tensile strength is said to be increased by fifty per cent. and the resistance of the surface against scraping to be imrpoved by two hundred per cent. In wear and warmth and appearance the philanized cloth resembles woolen.

We might suppose that the action of nitric acid on cotton would produce sulfuric acid is needed to facilitate the reaction of the nitric. In the present process the nitric acid merely attacks the surface and is all washed out afterward, or eliminated by alkali. The cotton acquires a yellowish tinge but this may be removed by bleaching. The Philiaized fabric may be later mercerized and this makes it look like linen. It is said to may be later mercerized and this makes it look like linen. It is said to dye more readily and brilliantly than unteated cotton. One of the leading German dye works is using the new process.

In England nitric acid is being applied to the improvement of ramie, an Indian fiber. When ramie under tension is treated with nitric acid, it acquires a silken luster. When not stretched, it resembles wool Three minutes dipping in the cold concentrated nitric acid is sufficient for the effect. The fiber gains slightly in weight and considerably in strength and takes dyes better.

The chemist has made a new market for cotton waste by dissolving it completely in nitric acid, alkaline sulfide, or acetic acid, and spinning out the viscous fluid into threads of any length, size and shape that he pleases, producing thereby a synthetic fiber that closely simulates silk in appearance if not in strength. Fifty per cent. of what seems to be silk nowadays comes from the chemical laboratory instead of from the cocoon. By taking on the chemist as an ally King Cotton is enlarging his realm.

Science Service.

UNIVERSE EXPANDS WHEN ASTRONOMER DISCOVERS OTHER STELLAR SYSTEMS.

The limits of the universe have been pushed outward and greater stellar systems comparable to our own tremendous galaxy are shown to exist by the astronomical research of Dr. Edwin Hubble that won for him half of the $1000 prize.

Using the largest telescope in the world, the 100 inch reflector at the Carnegie Institution's Mount Wilson Observatory at Pasadena, Calif., Dr. Hubble has solved the mystery of the great heavenly objects that look like pinwheels in the sky, the spiral nebulae.

Nearly overhead in the sky at the present time in the constellation of Andromeda there is the most famous of these spirals, the Great Nebula of Andromeda. To our eyes viewing it from the earth it has several times the area of the full moon although it is so faint that good sight is required to spot it in the heavens.

In small telescopes it looks merely like a cloud of matter, but when Dr. Hubble turned the great Mt. Wilson 100-inch telescope upon it, he found the outer ends of the spiral contain immense numbers of very faint stars, a hundred thousand to a million times fainter than the stars that the naked eye can see.

A study of such photographs and the application of known astonomical laws led Dr. Hubble to the following facts about the Andromeda nebula.

It is so distant that it takes light nearly a million years to travel from it to the earth. That is, it is some 6,000,000,000,000,000,000 miles away.

It is the most distant object known to science.

It is as large and has as much stuff in it as our own galaxy.

Its total light is one billion times that of the sun.

It contains some three or four thousand million stars.

In shape and form it is not unlike the great stellar system or galaxy which the Milky Way and most of the stars we see at night are a part and in which the sun and its revolving planets are but pin points.

It is at four times as great a distance as ever previously established for any celestial object, with the exception of the faint star cloud N. O. C. 6822 which Dr. Hubble has shown to be 750,000 light years from the earth.

It is an "island universe," a concentration of stars, gaseous stuff, and perhaps even planets, out in the space of the great all-inclusive or super-universe and billions of miles away from other universes or galaxies like our own.

And the spiral in the constallation Triangulum seems to be nearly a twin to that in Andromeda.

How can evidence of such gigantic "universes" be obtained?

First of all Dr. Hubble's photographs, better than any previously obtained, showed "dense swarms of actual stars" in the outer parts of spiral nebulae. Then it was found, by taking photographs night after night, that some of these stars were what is called Cepheid variables. They fluctuate in brightness, going through a period of sudden rise to brilliance and slow fall to dimness in times ranging from a few hours to 50 days. At maximum they range from 4000 to 8000 times the sun's brightness. This was the clue to the determination of the great distance of the nebulae.

Some years ago Dr. Harlow Shapley of Harvard worked out a useful relationship between star brilliance and the period of these Cepheid variables, so named because they are most prevalent in the constellation of Cepheus. He found that if the period of variation was known the

absolute brightness, dependent only upon the temperature of the star and not upon its distance from the earth, could be determined. A simple comparison of absolute brightness of the star with the brightness shown through the telescope tells the distance of the star from earth.

When Dr. Hubble applied this law to the variable stars he discovered in the Andromeda nebula, he found that they were all about 930,000 light years away in another island universe.

While Dr. Hubble is the first man to prove the distant existence of such vast conglomerations of matter outside our own locality of space, their character has been suspected for about a century. Sir William Herschel, English astronomer of 100 to 125 years ago, when he saw the spiral nebulae poetically called them "island universes". The name stuck and now Dr. Hubble has given it justification.

Undoubtedly more distant spiral nebulae, now known to be stellar galaxies, lie even farther out in space. There are more than 100,000 of these spirals known to astronomers and most of them instead of being great patches of light like the one in Andromeda, appear merely as points of light in telescopes and on photographs.

Imagination totters when it attempts to conceive of the distances that must intervene between the galaxies or "universes" and our own.

Space, or the super-universe, with the aid of Hubble, Einstein, and other scientists, has been swollen enormously in the past few years.

BIRDS WAGE WAR ON BOLL WEEVIL.

Winter tourists from the North destroy the boll weevil and white grub two deadly enemies of the southern cotton crop, and should, therefore, be protected by the farmers. The common pipit, a bird that goes south during the winter months, prizes the weevil and the grub as choice bits of his diet.

He is, moreover, the only species of winter bird that is an active help to the farmer. Regardless of traditions, the U. S. Department of Agriculture has proved that other winter birds are neither a help nor a hindrance to the farmers.

The stomachs of snow buntings and long spurs, common winter birds, show that their diet consists almost entirely of weed seeds. While this is a step in the direction of help they cannot eat enough to be of any material value. The birds are, however, vindicated of the charge of eating fresh, green buds.—*Science Service.*

EUROPEAN CHEMIST FINDS SUBSTITUTE FOR PLATINUM.

Platinum laboratory vessels, indispensable in certain chemical operations, have become very expensive, due partly to the increased use of platinum jewelry and partly to the virtual cutting off of the Russian supply, formerly the principal source of the metal. Dr. A. Gawalowski, an Austrian chemist, reports the successful use of vessels made of an alloy of silver and aluminum, thinly coated with platinum by an interesting process. The alloy was dusted over with "platinum black" a microscopically fine dust of platinum, and then hammered, or rolled under heavy pressure. This peculiar method of plating gave the alloy sufficient protection against the strong acids and alkalis of the chemical laboratory. —*Science Service.*

METHODS IN TEACHING BIOLOGY.

By Arthur G. Clement,

University of the State of New York, Albany, N. Y.

It is nearly a generation since the subject of biology as such was introduced into the secondary schools of the United States. It is not surprising that the methods of presenting it have during this period been topics of much discussion and have changed from time to time as the years have passed. This would occur in the case of any new study introduced into the curriculum of our schools.

The point of view in teaching biologic science has passed through several stages. For many years instruction in this subject with reference to plants consisted in the collection, recognition and naming of a number of flowering plants. Each student made a herbarium which usually containebout fifty ad specimens of flowers, pressed and mounted. Each plant was studied by itself. Little or no attention was given to its relation to other plants, to the soil or to the place it occupies in the realm of nature.

On the animal side the plan was similar except that animals were not collected. A textbook containing accounts of the structure and habits of animals, found in different parts of the world, was committed to memory and sometimes their economie value was discussed. As a whole, however, the study wa. descriptive zoology just as the study of plants was descriptive botany. The course provided tended to develop the memory and undoubtedly created some interest in the animal world.

In the study of human physiology, morphology received undue attention. The naming of the bones was considered important. Function as the true basis of physiology, however, has always received some attention.

For many years in most schools the three term plan prevailed and botany, zoology and physiology each received one third of the time. There was, however, no effort to correlate the subject matter of the different phases and present it as a single year course with an underlying principle that unified the three phases of the subject.

In the latter half of the 19th century a course of biologic study commonly known as the type course was introduced into our high schools. This kind of course was first carried on in England, where it was inaugurated by Huxley and later

was introduced into this country by Martin. A textbook in biology by Huxley and Martin was used as a basis of the study. This course as first presented required the study of a number of morphological facts concerning a series of plants and animals. It began with the study of lower forms, simple in structure and advanced step by step through the study of a series of organisms in an ascending scale to the higher forms. The method was almost wholly the method of verification and the avowed object was to substantiate the fact of evolution.

This course answered very well for college students anxious to acquire the comparative method of study. Many young teachers carried this method into the high schools where they became teachers, and the result was that for a few years in many schools children of the ages of 12 to 14 were engaged in dissecting crayfishes, frogs and other animals and to a limited extent in the dissection and microscopic examination of plant tissues. In most schools double periods were provided in order to enable students to complete their work. This method of study was popular for a few years, but it has gradually disappeared from the elementary course given in the first year.

A variation of this method known as the earthworm-fern course was a popular course in some colleges for several years. It consisted in an exhaustive study of an earthworm and a fern during which the processes common to animals and plants were compared, and the fact that each developed from a single cell was explained. This course did not secure a foothold in the high schools. As a study for college students it possessed many admirable qualities.

There is no doubt that a course of this nature properly carried on has training value for students mature enough to grasp the principles involved. It fails, however, to give information in regard to the various kinds of animal and plant life, so interesting and desirable for youth. It does not present sufficient variety to hold the attention of students of first year high school grade.

Another plan of study now advocated by some teachers consists in developing separately the physiology, morphology and ecology of several types of organisms. For example the morphology of the respiratory system is studied in a simple one-celled animal and in several many-celled animals successively as the complexity of structure increases in the ascent in the scale of life. The difficulty of this method lies in the fact that

the student's study of the topics is not closely enough correlated. These various characteristics of an organism are so closely related that it is difficult to gain an accurate idea of its appearance, its activities and its adaptations unless its structure, functions and adaptations have already been studied one after the other. The mind of the first year student grasps a complete conception only when its separate elements are arranged, at least once, in their natural relation in each organism studied.

The method then which seems most desirable in first year study is to consider the functions, adaptations and so forth of each organism in regular order and later, after several organisms have been considered to make a comparative study of the ways in which these various activities are carried on by the different organisms.

The following table will aid the student in grasping the unity of the subject in the study of man, other animals and plants with respect to function. It may be used either vertically or horizontally. In the former case each organism is studied separately with regard to each of its life processes; in the latter each function is considered separately with regard to a series of organisms. Most students prefer the first method in the preliminary study and use the second in review. A combination of the two methods is effective.

Man	*Other Animals*	*Plants*
Sensation	Sensation	Sensation (irratibility)
Motion	Motion	Motion (limited)
Respiration	Respiration	Respiration
Food-taking	Food-taking	Food-storing (after food-making)
Digestion	Digestion	Digestion
Absorption	Absorption	Absorption
Circulation	Circulation	Circulation (incomplete)
Assimilation	Assimilation	Assimilation
Excretion	Excretion	Excretion
Reproduction	Reproduction	Reproduction.

These functions may be arranged under three heads: (1) Functions of relation which embrace sensation and motion, since by means of these all organisms relate themselves to the external world. (2) Functions involved in nutrition, which embrace respiration, food-taking, digestion, absorption, circulation, assimilation and excretion, since all these are necessary to insure growth and repair, the release of energy and the keeping of the organism in health. (3) Reproduction in all the forms by which the continuation of the species is insured.

Gradually it has become apparent that the subject of biology when taught to children of the age of those usually in the first year of the high school should emphasize the study of living things rather than the dissection and observation of dead organisms.

The report of the commission on the Reorganization of Secondary Education referring to the content of a general biology course says "that a course in biology in the ninth or tenth year should be what the name implies, a study of living things. Along with this sentiment has developed the idea that the interests of man should be paramount in this study. It follows, then, that the topics which are related in the closest way to his interests should receive the greater amount of attention.

It is generally acknowledged that the most important topics, aside from those bearing on hygiene, are food plants, insects, birds, mammals, micro-organisms and fungi that cause destruction of plant life.

Let us consider each of these topics briefly. Since the green plant manufactures all the food in the world the importance of knowing something about the conditions under which it works and its life processes is evident. If the plant ceases to produce food it will perish. If all plants do likewise, animals, including man, must also perish on account of lack of food. Hence, the importance of the study of plants.

Plants have enemies, chief among which are insects. The danger to our food supply from insects seems to increase as civilization advances. There is scarcely a plant that has no insect enemy. It therefore becomes important for man to know what insects are injurious to the plants which produce the food necessary for his existence, in order that he may control their increase. There are some insects whose activities are beneficial to the interests of man, hence it seems desirable that he should know these and endeavor to protect them and encourage their increase. By the study of the structure, life history and the habits of various insects man is soon able to combat the unfriendly ones and to preserve those which assist him. The study of insects then seems to be an essential part of a course in biology.

But green plants have other dangers besides insects, among which are low forms of plant life that attack their tissues, absorb their nutrients and often destroy them. Among these forms

are various kinds of fungi. Food plants must be protected against them as well as against insects. Duggar in his book "Fungous Diseases of Plants" mentions 238 fungi that attack common plants and trees of garden, field, orchard and forest. To neglect the control of these is to invite famine. Methods of preventing the harm they accomplish may well form a part of every course in biology.

The study of birds should form a part of every biology course, not merely because it develops the aesthetic qualities of the mind but because birds aid in the control of the vast number of insects that annually appear. By destroying these the birds aid in keeping the balance of nature.

No one ought to question the idea that mammals should be studied. There has been a tendency to neglect this study and to give undue attention to the study of Amoeba and other low forms of animal life not so closely connected with the interests of man. But this is changing. The committee on the reorganization of science in secondary schools declares that in biology a much larger place than is usual should be given to the study of mammalian life since the life of many common mammals is so closely connected with the interests of man. This advice seems sensible and opportune.

On account of their economic importance as well as their relation to the health of persons, micro-organisms should receive due attention. The practice, however, of requiring first year students to spend hours over the compound mircoscope in studying them ought not to be encouraged. The time may be more profitably spent in observation of larger things which require only the unaided eye. The lecture demonstration method is far more effective. This method is easily carried on by the use of slides and the projection lantern. Dr. Elliott R. Downing of the School of Education, Chicago University, would debar all use of the compound microscope in the study of biology in the high school and substitute therefor the demonstration method using the projection microscope.

The practice of dissection of animals by first year high school students has not the educational value sometimes ascribed to it. In place of it children are encouraged to study animals that are alive and as far as possible in their natural environment.

Bearing on the tendency to over emphasize the importance of dissection, Dr. Needham in the preface to his zoology says "It has been a popular delusion that a term of dissections con-

stitutes a proper elementary course. Such a course was an improvement on former methods; the study of dead animals is infinitely better than no contact with animals at all. But to study animals with nature and life left out is to omit a phase of the subject of deepest scientific interest of highest educational importance, and of greatest pedagogical utility."

In regard to the content of a general biology course the words of the committee on the Reorganization of Science in Secondary Schools may well be heeded. The committee believes that a course in biology in the ninth and tenth years should be what the name implies—a study of living things. The central idea should be

1. "The way in which each organism maintains its own life and the life of the species."
2. "The interrelations between different organisms and groups of organisms."
3. "The constant dependence upon and interrelations of living things with the physical world about them."
4. "The power of man to control the habits and relationships of plants and animals to serve his own ends."

MOTHER'S VITAMIN SUPPLY CONTROLS VIGOR OF YOUNG.

Possibility of decreasing materially the death rate among infants has been greatly enhanced by the discovery of the relation of the newly discovered reproductive vitamin to certain vegetable oils, according to Dr. Barnett Sure of the University of Arkansas.

The new vitamin, named Vitamin E by Dr. Sure, has been traced to certain vegetable oils in recent investigations. Earlier experiments by Dr. Sure, and Dr. H. M. Evans and Dr. Katherine Bishop of the University of California, who label the vitamin "X," had shown that animals fed on complete rations, including necessary amounts of all known vitamins, grew normally but failed to continue the race. A new "reproductive vitamin" was therefore indicated.

It was established that certain kinds of oil-containing seeds retained normal powers of reproduction, wherefore the investigator undertook to find what part of the seeds contained the vitamin. He separated the oily substances from the starchy bulk of the seeds by extracting with ether, benzene, or acetone, and then distilling off the solvents. Animals fed on starchy residues were unable to reproduce, but others fed on a diet containing the extracted oils had normal offspring.

The oil extracts thus far used by Dr. Sure in his experiments have been taken from yellow corn, wheat embryo, and hemp seed. From work, so far completed, the vegetable oils are tentatively divided into the four following groups:

1. Those oils that do not even produce fertility. In that group belong commercial linseed, cocoanut, and sesame oils.

2. Those that produce fertility, but fail in lactation, or milk secretion and nursing of young. In this group belong commercial olive oil, the oil of the peach kernel; and peanut and soy bean oils directly expressed.

3. Those oils that produce fertility, and are only partly successful in lactation. In this group so far studied, cotton seed oil belongs.

4. Those oils that are potent for both fertility and successful lactation In this group belong wheat germ oil, corn oil, and hemp seed oil, prepared by extraction with ether, benzene, or acetone.

Vitamin E is indispensable for both fertility and lactation, but in the same series of experiments Dr. Sure reports that Vitamin B, in addition to being essential for growth, also performs a significant role in milk secretion after the young are born.

This recent addition to the vitamin family appears to be the most potent of all, as it has been found that as little as three-quarters of a milligram of E, or 1-480,000 of a pound, per day is sufficient for fertility. The latest experiments show that the supply of vitamin E controls in a quantitative way, the volume of milk secretion, and the vigor of the young, and it has proved possible to grade the age to which young rats will live by controlling the supply of the fertility vitamin which their parents receive.

Dr. Sure declared that the greatest proportion of mortality among human beings takes place between the ages of one and three and among infants the greatest losses of babies occur during the first year of life—during the nursing period.

"Undoubtedly the cause of such fatalities among human babies must be attributed to either insufficient milk flow or poor quality of milk or both," he declared. "Heretofore the relation between faulty lactation and the diet has not been appreciated. Insufficient milk flow in the human mother is not the unusual thing. It is rather the usual thing, and, therefore, the medical profession has been, in the majority of cases, absolutely handicapped in its efforts to help mothers successfully to nurse and wean their children because of a lack of a scientific understanding of the dietary needs during the nursing period."

Dr. Sure hopes that it will soon be possible to help many mothers along this line.

SCIENTISTS PRY INTO SECRETS OF VOLCANOES' DEPTHS.

Relief valves of Hell! Such was the old idea of the function of volcanoes, supposed to tap the center of an earth filled with a molten magma that would make the Devil himself envious.

But now, although volcanoes still terrify those who live near them, geologists say they are mere boils on the skin of the earth. The interior of the earth is solid and hard, and volcanoes are not constitutional but merely superficial phenomena.

Volcanoes have always held for men the double fascination of the terrible and the unknown. It is no wonder then that primitive peoples made these fire-mountains the abodes of their most terrible and angry gods, and that volcanoes all over the earth—Etha, Fujiyama, Kilauea, Popocateptl—have become objects of religious tradition or superstitious awe.

Other times, other man, other ways. Western civilization now looks no longer with dread at the chimneys of Vulcan's forge, and even the swartny children of the Pacific Islands have learned to withhold their propitiatory offerings of living victims from the goddess of the fire-pit. Man may now go where he please, and question what he will, even volcanoes.

But though man has been prompt and curious in the exercise of his freedom to question nature, many secrets are still not made manifest. And of these, among the least satisfactorily explained are the secrets of the volcano. Men may climb a fire mountain during an interval of peace

they may descend the inner slopes of its crater to its very heart and feel the pulse of the seething lava lake at its bottom, they may breathe (though at their peril) of the volcanoe's very breath; but the roots of the mountain, deep in the bosom of the earth, no man has ever seen. And until someone does, the mystery of the eruptions, of the still tides of lava that sometimes pour down the mountain's sides, of the belching storms of ash and pumice that roar into the air, will not be wholly unveiled. In the meantime, one investigates as far as one's means permit, and builds hypotheses.

In the earlier days of the modern era of science, when the earth was thought to have started its career as a huge ball of liquid magma, slowly cooling off until a thick crust surrounded a still fluid interior, volcanoes were thought to derive their lava and flames from this interior reservoir of heat. But geologists and mathematical astronomers some time ago routed this idea ,and volcanoes were deposed from their jobs as cosmic safety-valves. The interior of the earth has been shown to be virtually as rigid as steel, and volcanoes are reduced to mere local affairs, and dependent upon local supplies of lava for their fireworks.

The theory proposed pictured the base of a volcano as sitting over a considerable mass of lava, bearing the same relation to it as the narrow neck does to the body of a bottle. Some volcanologists even held that certain groups of volcanoes were connected by common conduits to the general supply of lava beneath, like a bottle with several necks.

Now comes Dr. Arthur L. Day, director of the Geophysical Laboratory of the Carnegie Institution of Washington, and denies volcanoes even this limited bellyful of fire. His investigations, conducted for many years on many volcanoes, but especially on great Kilauea in Hawaii and on our own neighborhood volcano, Lassen in California, have led him to the conclusion that the sources of the lava in volcanoes are scattered in small masses in many rifts and pockets. His picture of the roots of a volcano would be a picture closely resembling that of the roots of a tree.

As for interconnection between volcanoes, Dr. Day scouts the idea. He points out the case of two Hawaiian volcanoes, Mauna Loa and Kilauea. Mauna Loa is 10,000 feet higher than Kilauea, yet it erupts lava much more frequently than does Kilauea, which would hardly be conceivable if the two were interconnected. Lava is three times heavier than water, and certainly no more ready to flow uphill. Moreover, he says, the activity of one volcano rarely finds an echo in that of the other.

Dr. Day's conclusions as to the true aspect of the underneath parts of the volcano are the results of his studies of the temperatures of the lava in the great pool of Kilauea, and on the chemical nature of the gases that bubble up through the boiling lava. One of the first things that led him to suspect the truth of the "boiling flask" theory was the discovery that the temperature of the lava at the surface of the lake in Kilauea was higher than it was at a short distance beneath. Lava temperatures ahywhere are high enough. The surface temperatures in Kilauea's lava pool averaged 1000 degrees Centigrade, or about 200 degrees Fahrenheit. But a few feet beneath the surface they stood about 100 degrees centigrade lower.

Here then was a puzzle. Something must be happening in the liquid lava immediately within reach, some chemical charge that was releasing energy in the form of heat. And the process must be going on up to the very surface itself. Dr. Day set about finding some phenomenon that might explain it. He and his assistants put on gas masks, and they collected the gases that bubbled out of the liquid stone in special apparatus. Chemical analysis showed these gases to be of the most varied constitu-

tion. He found a list of eleven: nitrogen, water (as steam), carbon dioxid, carbon monoxid, sulfur dioxid, free hydrogen, free sulphur, flourine, ammonia, and even argon, a rare atmospheric cas. Now, some of these elements and compounds are chemically very active; at the high temperatures that prevail in the pool it can hardly be imagined that these gases have come up together from some central source without uniting. It is more probable that they have come from several independent sources, are uniting very actively as they approach the surface and giving off heat as they do so, and thus causing the paradoxical situation of higher temperatures at the surface than just beneath it.

Having thus found an explanation for the peculiar behavior of lava temperatures, Dr. Day turned to the problem of the source of the energy for such explosive eruptions as that of Lassen Peak in 1915 ,and the historic Vesuvious eruption that buried Pompeii. Volvanic eruptions of the explosive type are accompanied as a rule by huge outbursts of steam, which condenses in the cold outer atmosphere and falls as rain; frequently mixed with volcanic ashes as a rain of mud.

Dr. Day, like a modern Moses, paradoxically shows that water can be squeezed from solid rock. He said: "Freed from chemical terminology the mechanism is simply this: Á silicate solution in its liquid state can take up water in solution in considerable quantity. A simple solution of silica and potash when heated under pressure in the laboratory is capable of taking up as much as 12.5 per cent of water in solution. A rock magma in the earth is such a silicate solution, although more complicated in character, and is entirely competent to carry five or six per cent of water in solution under appropriate conditions. If it should happen that the lava beneath a volcano carries such quantities of water in solution, then all the phenomena of volcanism become appreciably clearer, for in the 8000 or more analyses of crystalline rocks of igenous origin which have been gathered together there is none containing more than one and one-half per cent of water, and less than one per cent is usual. This must mean that in the process of crystallization of the rock from the magma the water content is for the most part discharged. Should it happen that this discharge of water takes place in a closed space then immense pressures might develop and explosive activity of tremendous intensity might result."

COURT FREES INDIAN WHO EATS RARE ROOT.

That Indian wizards possess a root which when chewed in a court room will give off a perfume and alter the minds of judge and jury toward the prisoner, is the claim of a Chickasaw interpreter presented to the American Association for the Advancement of Science by Dr. John R. Swanton of the Smithonsian Institution. Dr. Swanton stated that he was merely telling various beliefs connected with witchcraft among the Indians as they had been told to him, but could not say to what extent the aboriginal beliefs had been added to from white and negro sources.

Wizards were employed by the Chickasaws, his informant said, to help win ball games. When the people heeded the wizard's warning they usually won, if he was better than the conjurer on the other side. When his side won, the conjurer was well paid but when they lost he received nothing. If he was suspected of helping the opponents, he was killed. When a game was in prospect the conjurer had to begin his preparations several days in advance. He had to fast for a certain number of days, drink medicine made from certain herbs, and was not allowed to sleep. After the game, he usually felt sick for several days on account of the sleep he had lost and the medicines he had taken.

NAVY DIRIGIBLE ECLIPSE EXPEDITION SAW BRILLIANT CORONA.

By Watson Davis,

Managing Editor Science Service, Press Representative on Navy Dirigible U. S. S., Los Angeles During Eclipse Flight.

A corona surpassing in brilliance any such phenomena observed at previous eclipses within the experience of the U. S. Naval Observatory astronomers rewarded the flight of the Navy dirigible Los Angeles January 24.

Piloted by Commander J. H. Klein, Jr., to a mile above the surface of the ocean and some twenty miles east of Long Island, avoiding a lower menacing layer of clouds and rising above the hazy smoke of civilization, the giant airship furnished a nearly ideal observatory for the astronomers, who were headed by Capt. Edwin T. Pollock, superintendent, U. S. Naval Observatory. Some apprehension was felt before the eclipse as to the steadiness of the ship during the vital seconds of totality, but the eighteen photographic plates exposed through the four telescopic cameras on board operated by Prof. George H. Peters and C. B. Watts, Naval Observatory astronomers are expected to give interesting and valuable results when developed. C. C. Keiss, of the U. S. Bureau of Standards, operating a photographic spectroscope, exposed four plates, while W. L. Richardson, Navy photographer, with motion picture camera lashed to the exterior of a motor gondola ground out many feet of film. In a small cockpit on the top of the dirigible, A. K. Peterson, chief photographer, U. S. N., and an aviator, braved a frigid breeze blowing 40 miles an hour to secure motion pictures of the partial eclipse and the corona. Two members of the dirigible's crew manned a special automatically timed camera for photographing the fleeting shadow bands that preceded and followed totality and officers and members of the crew sketched the corona as it appeared visually.

Descriptions and drawings of the corona when compared and discussed after the eclipse flight ended revealed the fact that the corona had been unusually bright and that the coronal streamers on the upper right or northwest side of the sun showed remarkable extension. Long streamers were also visible extending from the lower left or southeast side of the eclipsed sun, while the corona was bushy and short at right angles to these two directions. This is characteristic of the corona at a time when there are not many sunspots and this coincided with expectations since a minimum point in the sunspots cycle of 11.3 years was reached only two years ago. Never before had the sun's corona been satisfactorily observed at just this point in the sunspot cycle, however, and it is expected that the photographs obtained will be of great value to the astronomers who are attempting to solve the riddle of the composition, cause, and movements of the magnificent surroundings of the sun seen by man only during eclipses.

The brilliance of the spectacle must have been due chiefly to the great height reached by the Los Angeles and the clear weather but it is also true that conditions in the sun itself contributed largely.

In my personal observations of the corona, I paid special attention to the prominences or great sheets of incandescent gases that are seen jutting out from the edge of the moon-darkened sun. I was able to distinguish three of these prominences at Saturday's eclipse, one just slightly east of the top of the sun, one on the east limb and one on the west limb. I was surprised that these were not as red as descriptions of previous eclipses had led me to expect. In fact, they looked to me to be yellow-orange;

yet they were in distinct contrast to the brilliant white of the corona that extended outwards at least two diameters of the sun. There is another phenomenon, which for the sake of my eyes and my veracity, I hope will be shown in the coronal photographs and motion pictures. A minute after totality had begun, I saw movement in the inner corona just above the prominence at the top of the sun. This took the form of semicircular arc beginning some thirty degrees to the east of the top of the sun and ending about at the top edge. My observation of this moving semi-circular band was interrupted by the ending of totality. When a great jewel of light appeared on the west edge of the sun, I noticed that I could still see the corona, although the increasing light had blotted out most of its extension. I started counting seconds and it was not until 22 seconds had passed that the corona was entirely obliterated by the reappearing sun.

This persistence of the corona makes it possible to believe two witnesses of the eclipse who were at Lakehurst during the event. Although the eclipse was only 99 per cent total there, they were able to describe accurately the appearance of the corona, evidently demonstrating that sharp eyes are able to see the corona even where the eclipse is not quite total.

Luna maintained her reputation for fickleness when she caused the eclipse to board the Los Angeles eight seconds late according to Prof. F. B. Littell of the Naval Observatory who had charge of the timing of totality. Lags of from three to five seconds are reported from land stations. Time signals were received on the Los Angeles by radio and the ship's chronometer was checked before and after totality.

The radio room of the Los Angeles, in charge of Lieut. T. W. G. Settle, was one of the busiest places on the ship. In addition to the usual interchange of messages between the ship and her hangar home at Lakehurst, conveying weather information and orders, radio compass bearings were sent to and received from six Navy radio stations at intervals of from five to thirty minutes between the time the ship took the air and the time of eclipse. This radio information and visual bearings and ranges were used by the ship's navigator, Lt. Com. J. M. Deem, in fixing the ship's course so that the cameras in the cabin would point directly at the eclipsed sun. An account of the expedition was sent to all press association by wireless while the ship was still in the air and a short description was radiophoned on 500 meters as an experiment in the hope that cooperating broadcasting stations would pick it up and rebroadcast it to the public.

THE CARUS MATHEMATICAL MONOGRAPHS.

A book is just off the press which promises to be the beginning of a far-reaching epoch in American mathematical literature and to have a vital interest for teachers of mathematics in the secondary schools and in the junior colleges. It has long been felt that if the various mathematical subjects could be set forth in a somewhat expository form in a manner comprehensible to those who have only a moderate acquaintance with elementary mathematics, say through a year's introductory course in the calculus, and if such expositions could be made attractive and accessible at moderate cost, then many more would be glad to extend their mathematical knowledge and to keep in touch with the developments in these fields.

Acting in this belief, Mrs. Mary Hegeler Carus and her son, Dr. Edward H. Carus, conceived the plan of making a series of such mathematical expositions available and to this end Mrs. Carus made a notable gift

to the Mathematical Association of America under whose auspices she wished to have these prepared and published.

During the past three years arrangements have been quietly going forward for carrying out this plan and now (February, 1925) the first of the Carus Mathematical Monographs is ready for distribution. It is entitled *Calculus of Variations* and was prepared by Professor G. A. Bliss of the University of Chicago. It is a book of 183 pages (3½x6) on a subject of historical and practical interest, written in attractive style, with a minimum of technical detail, and with careful expositions of all the mathematical methods used. The author presupposes on the part of the reader only a working knowledge of the differential and integral calculus throughout the first four of the five chapters where the expositions are gathered about certain historical problems. In the fifth chapter, where the more general theory is discussed, certain elementary properties of differential equations are needed but these have already been clearly illustrated in the preceding chapters and their applications are described in detail in the text.

It is hoped that this monograph may stimulate many secondary teachers to renew their calculus acquaintance and to gain real pleasure in the reading of this interesting and luminous exposition of a subject which has attracted the profound consideration of leading mathematicians since the time of Newton.

These monographs are distributed at cost to members of the Mathematical Association of America whose applications should be sent directly to the Secretary, Professor W. D. Cairns, Oberlin, Ohio. They will be distributed to the public at large by the Open Court Publishing Company, 122 South Michigan Avenue, Chicago, Illinois, at two dollars per copy.
Chicago, Illinois. H. E. SLAUGHT.

ACCURATE EARTHQUAKE PREDICTIONS POSSIBLE.

Earthquakes may soon be predicted with as much certainty as forecasts of storms or floods are now made. The preliminary shiftings and writhings of the earth's crust, imperceptible to human beings but easily detected by sensitive instruments, have been successfully used by scientists at Volcano House, on the rim of the crater of Kilauea, to give warning of a coming quake.

On the first occasion when a test case was made, it was observed during a period of about a month that there was a decided southerly tilt of the crater's north rim. This suddenly changed to a northerly tilt at the end of the month, and a few days later veered back to its original position. Had such changes occurred when the crater was full of lava they would have been alarming, but fortunately the volcano was nearly empty at the time. On the strength of the position changes, however, it was predicted that a perceptible shock would come within a few days. The prophecy was fulfilled two days later, when a shock, not severe but quite perceptible, rocked the island.

R. H. Finch, of Volcano House, who describes the method used in predicting, adds that some of the popular ideas about preliminary symptoms of earthquakes have very little solid support. The so-called "earth quake weather," he says, is an unreliable indication. During the first part of 1924 in Hawaii there was a long spell of such sultry and oppressive weather, with an unusually small number of shocks.

PROBLEM DEPARTMENT.

CONDUCTED BY J. A. NYBERG,
Hyde Park High School, Chicago.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

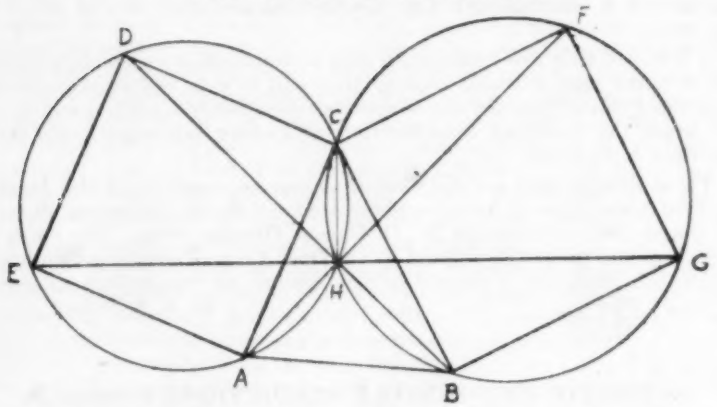
All readers are invited to propose problems and solve problems here proposed. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to J. A. Nyberg, Hyde Park High School, Chicago.

LATE SOLUTIONS.

870. *Vivian Skogman, Paul Stanius, Cambridge, Minn.*

SOLUTIONS OF PROBLEMS



871. *Proposed by George Sergent, Guatemala, C. A.*

(Suggested by problems 841, 856.) On the side AC of any △ ABC the square ACDE is constructed, and on the side BC the square BCFG. Prove that the lines AF, BD, and EG are concurrent.

I. *Solved by Michael Goldberg, Philadelphia, Pa.*

Circumscribe circles about the squares, denoting the second intersection point by H. Join A, B, C, D, E, and F to H.

Since the diagonals EC and CG would be diameters, angles EHC and CHG would be right angles (inscribed in semicircles), and hence EAG is a straight line.

∟CHA is measured by half of three-fourths of a circumference; and ∟CHF is measured by half of one-fourth of a circumference. Hence ∟CHA+CHF=180°, or AHF is a straight line.

Similarly, DHB is proved to be a straight line.

∴EG, DB, and AF are concurrent at H.

II. *Solved by C. N. Mills, Aberdeen, So. Dakota.*

Use the point C as the origin of coordinates, CB as the positive X axis, and assign the following coordinates: C(o,o); A(b, c); B(a, o). Then the coordinates of the other points are: D(—c, b); E(b—c, $b+c$); F(o,—a); G(a,—a). The equations of the required lines are:

$$\begin{array}{lrcrcl} \text{AF:} & (a+c)x & - & by & -ab & =0 \\ \text{BD:} & bx & + & (a+c)y & -ab & =0 \\ \text{EG:} & (a+b+c)x & + & (a+b+c)y & -2ab & =0 \end{array}$$

The condition for concurrency is the vanishing of the determinant

A New Angle on Mathematics

SMITH'S
ESSENTIALS OF GEOMETRY

New geometries organized to make the great basal propositions stand out clearly. A sane and thorough grounding in fundamentals—which means fewer headaches over originals.

SMITH & REEVE'S
ESSENTIALS OF ALGEBRA

The *use* of Algebra will be questioned by no student of these books—books which bring out the usable parts of algebra like the formula and the graph.

Ginn and Company

Boston New York Chicago
Atlanta Dallas Columbus San Francisco

A New Edition **Revised and Enlarged**

Mathematical Wrinkles The Teacher's Source Book

Extracts from a review of this work by Robert R. Goff, appearing in September, 1924, issue of "Education."

"This is the revised edition of 1923 and it is a most interesting and unique book. There is nothing else just like it. It has a vast number of problems of arithmetic, algebra and geometry, both serious and amusing. The 260 Mathematical Recreations make it a source book in that line."

"Under informational material might be listed: an excellent non-technical discussion of the fourth dimension; a very complete hand-book of mensuration; short methods and tables; worth-while quotations on mathematics; historical notes; as a curiosity, pi is carried out to 707 places."

"For help in the classroom or for entertainment and stimulation, I recommend this book most highly to all who are interested in mathematics."

12 mo. 336 pages. Half Leather. Attractively illustrated and beautifully bound.

ORDER IT NOW! **PRICE $2.10 POSTPAID**

S. I. JONES, Publisher, Life and Casualty Bldg., Nashville, Tenn.

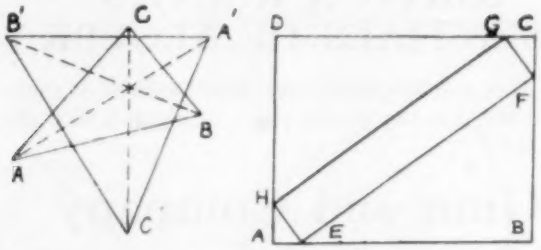
$$\begin{vmatrix} a+c & -b & -ab \\ b & a+c & -ab \\ a+b+c & a-b+c & -2ab \end{vmatrix}$$

and this can easily be proved equal to zero.

The theorem is also true if the squares are drawn so as to overlap the given triangle, in which case the equations of the lines are

$$\begin{array}{lccccc} AF: & (a-c)x & + & by & -ab & =0 \\ BD: & bx & - & (a-c)y & -ab & =0 \\ EG: & (a+b-c)x & - & (a-b-c)y & -2ab & =0 \end{array}$$

Also solved by *J. F. Howard, San Antonio, Tex.*, by the *Proposer*, and by the *Geometry Class of the Beech Grove H. S., Ind.*



872. *Proposed by D. L. Mackay, New York, N. Y.*

Given A′, B′, C′, the centers of the squares constructed on the sides of △ABC, to construct the triangle ABC.

Solved by George Sergent, Guatemala, C. A.

The construction is based on the following theorem:

If on the sides of △ABC as hypotenuses, isosceles right triangles AC′B, BA′C and AB′C are drawn, the diagonals of the quadrilateral formed by the vertices A′, B′, and C′ of the isosceles right triangles and a vertex of the given triangle are equal and perpendicular to each other.

Construction: From C′ draw the perpendicular to A′B′, and lay off on it C′C = A′B′. Then C is a vertex of the required triangle. The vertices B and A are determined in the same way: B′B equal and perpendicular to A′C′, and A′A equal and perpendicular to B′C′.

The theorem quoted above is suggested as problem 886.

873. *Proposed by C. E. Githens, Wheeling, W. Va.*

Prove that the cube of any number when divided by 6 leaves the same remainder as does the number itself when divided by 6.

I. *Solved by Raymond F. Schnepp, Chaminade College, Clayton, Mo.*

Let n = any number. Then $n = 6P + Q$, where P is the integral quotient when n is divided by 6, and Q is the remainder. Then

$$n^3 = (6P)^3 + 3(6)^2Q + 3(6P)Q + Q^3.$$

Each of these terms except the last is a multiple of 6. Since $Q < 6$, it is sufficient to show that the cube of any of the first five integers, when divided by 6, leaves a remainder equal to the integer itself, a fact verified by trial.

Lot 736—S. S. & M. June Mono—24 picas 8 pt. 8a on 8 Valade Gal. A4

II. Solved by R. T. McGregor, Elk Grove, Cal.

The expression $n(n+1)(n-1)$, where n is an integer, is a multiple of 6. The identity $n^3 \equiv n(n+1)(n-1)+n$ then shows that the remainder obtained for dividing n^3 by 6 must arise from dividing the term n by 6.

Also solved by *Tillie Dantowitz, Kensington H. S., Philadelphia, Pa., Walter C. Eells, Whitman College, Walla Walla, Wash.; J. S. Georges, University High School, Chciago; Michael Goldberg; C. F. Holmes, Elizabeth City, N. C.; W. W. Horner, Redstone H. S., Republic, Pa.; J. F. Howard*, and the *Proposer*.

Key to the Snakes of the United States, ACanada and Lowe California, by Frank N. Blanchard, University of Michigan. With 78 text figures. Pp. xiii+65. Cloth. $1.75 net.

"I believe that everyone who is interested in snakes at all is interested in identifying them. The characters employed in their classification are usually of such nature that the study of this group makes an excellent introduction to vertebrate systematics in general. Such a key as the one drawn up by Dr. Blanchard will be equally of service to the amateur naturalist to answer the question 'What snake is that?' to the museum worker to enable him to name an unfamiliar species, and to the teacher of nature study or of systematic zoölogy who wishes his students to identify specimens for themselves.

"Dr. Blanchard is greatly to be complimented on the form of the Key, which combines compactness with clarity, and introduces the explanatory figures exactly where they are needed."

—Karl P. Schmidt, Field Museum of Natural History
Chicago, Ill.

"This is a painstaking and accurate piece of work. It will be indispensable to every high school and college teacher of biology and to most students as well. Here at last the amateur can find out the identity of the snakes which he sees on his rambles about home. The work is based on prolonged study of adequate material, and, except for 'Wall's Key to the Snakes of India,' it is unique. On the whole Blanchard's treatment is rather more satisfactory than Wall's and the work is somewhat easier for an inexperienced student to follow. Handbooks of this sort are of the highest usefulness and Dr. Blanchard is to be congratulated on the completion of a real service to American Natural History."

—Dr. Thomas Barbour, Museum of Comparative Zoölogy
Cambridge, Mass.

THE GENERAL LIBRARY, University of Michigan
Ann Arbor, Michigan

Slide Rule Class at Hyde Park High School, Chicago, Ill.

The Slide Rule
IN TRIGONOMETRY

The use of the Slide Rule as a check in Trigonometry is now regularly taught in colleges and high schools. Our manual makes self-instruction easy for teacher and student.

Write for descriptive circular of our Slide Rules and information about our large **Demonstrating Slide Rule** for use in the class room.

KEUFFEL & ESSER CO.

NEW YORK, 127 Fulton Street General Office and Factories, HOBOKEN N. J.

CHICAGO 518-20 S. Dearborn St. | ST. LOUIS 817 Locust St. | SAN FRANCISCO 30-34 Second St. | MONTREAL 5 Notre Dame St. W.

Drawing Materials, Mathematical and Surveying Instruments, Measuring Tapes

874. *Proposed by Donald C. Steele, Greensburg, Pa.*

In a rectangular room 12 ft. by 15 ft., a strip of carpet 3 ft. wide is placed diagonally so that the corners of the carpet touch the sides of the room Find the length of the carpet.

I. *Solved by J. F. Howard, San Antonio, Texas.*

Denote the corners of the room by A, B, C, and D, and the corners of the carpet by E, F, G, and H, with E on AB, F on BC, etc. Let $AE=b$, $AH=a$, $EF=l$. Then

$$a^2+b^2=9 \text{ and } a/(15-b)=b/(12-a)=3/l,$$

or $4b^4-60b^3+333b^2+270b-1215=0$. Solving by Horner's method gives $b=1.757$, and hence $a=2.432$ and $l=16.336$.

The equations may also be solved graphically by finding the intersection of the circle $a^2+b^2=9$ with the hyperbola $a^2-b^2-12a+15b=0$, whose center is $(6, 7\frac{1}{2})$ and whose axes are $4\frac{1}{2}$, $4\frac{1}{2}$.

II. *Solved by W. W. Horner, Redstone H. S., Republic, Pa.*

Denoting AE by x, and eliminating l from the equations

$$l^2=15^2-3^2+(12-2x)^2 \text{ and } l^2=(15-\sqrt{9-x^2})^2+(12-x)^2$$

which are obtained from the right triangles, we get

$$x^4-12x^3+83.25x^2+54x-486=0$$

Horner's method gives $x=2.4317$; hence $l=16.34$.

Also solved by *George Sergent* who reduced the biquadratic equation to a cubic, and by Cardan's formula found $x=2.4317$, and $l=16.338$.

875. *For High School Pupils. Proposed by Norman Anning, Ann Arbor, Mich.*

Explain the magic in the following: Choose any number except 0 or 1, and perform the following operations in succession: (a) subtract from 1, (b) find the reciprocal, (c) subtract from 1, (d) find the reciprocal, (e) subtract from 1, (f) find the reciprocal. Now, if you have worked correctly, I can tell what your result is.

Solved by Tillie Dantowitz, Kensington H. S., Philadelphia, Pa.

Starting out with the number x and performing the successive operations we have the complex fraction

$$\cfrac{1}{1-\cfrac{1}{1-\cfrac{1}{1-x}}}$$

which, when simplified, reduces to x the number started with.

No other solution was received. The appearance of the complex fraction was evidently discouraging. The work, however, is not complicated if the result of each operation is simplified before the next operation is performed. Thus the steps may be written:

(a) $1-x$ (d) $\dfrac{1-x}{-x}$

(b) $\dfrac{1}{1-x}$ (e) $1-\dfrac{1-x}{-x}=\dfrac{-1}{-x}$

(c) $1-\dfrac{1}{1-x}=\dfrac{-x}{1-x}$ (f) $\dfrac{-x}{-1}=x$

PROBLEMS FOR SOLUTION.

886. *Proposed by George Sergent, Guatemala, C. A.*

If on the sides of $\triangle ABC$ as hypotenuses, isosceles right triangles AC'B, BA'C, and AB'C are drawn, the diagonals of the quadrilateral formed by A', B', C' and any vertex of the given triangle are equal and perpendicular to each other. (See problem 872.)

887. *Proposed by C. E. Githens, Wheeling, W. Va.*

A note in the Pictorial Supplement of a Sunday paper recently called attention to the moving of an obelisk around a street corner. Reference was made to the fact that this was a problem for a mathematician. Hence:

AGENTS WANTED

To represent *School Science and Mathematics* in the many Summer Schools of the United States and Canada this season. To advertise it and take subscriptions. A splendid opportunity to meet all or a part of your expenses. Write the business manager for particulars.

School Science and Mathematics

2055 East 72nd. St. - - - - Chicago, Ill.

"School Science and Mathematics" bears the same relation to progressive Science and Mathematics Teaching as does the "Iron Age" to the Hardware business. No up-to-date Hardware merchant does without this trade Journal. Every Science and Mathematics teacher should be a subscriber to the professional trade Journal, "School Science and Mathematics."

MATHEMATICAL BOOKS
—Ancient and Modern

Send for our Catalogue
GALLOWAY & PORTER
University Booksellers
CAMBRIDGE (England)

We do all varieties of the best printing. Submit to us your jobs and be sure of satisfaction.

Dependable and worth while

BIOLOGICAL SUPPLIES

Large stock of material in Zoology, Botany, Life Histories and Microscope slides.

For the student, the class room, the museum.

New Zoological and Life History Catalogs.

Catalogs free, Zoology, Life Histories, Botany, Microscope slides.

The world renowned.

Supply Department
MARINE BIOLOGICAL LABORATORY
GEORGE M. GRAY, Curator
Woods Hole, Mass.

Please mention School Science and Mathematics when answering Advertisements.

Two streets, each 60 ft. wide cross at right angles. Neglecting the width and thickness of the obelisk, and the width of the sidewalks, what is the longest obelisk that could be moved around the corner?

888. *Proposed by Walter C. Ells, Whitman College, Walla Walla, Wash.*

For what value or values of s is it true that the cube of any integer, when divided by s, leaves the same remainder as does the integer itself when divided by s?

889. *Proposed by C. N. Mills, Aberdeen, So. Dak.*

Prove that the area of the largest square that can be inscribed in a semi-circle of radius r is $4r^2/5$.

890. *For High School Pupils. Proposed by J. S. Georges, University High School, Chicago.*

Find the area of the five-pointed star whose diagonal is a.

NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS.

Report of the Ninety-Third Meeting of the New England Association of Chemistry Teachers (third meeting of the Northern Division) held at the University of New Hampshire, Durham, N. H., on May 2, 1925.

At 10 a. m. President Johnson introduced Professor Charles James, Head of the Department of Chemistry at the University of New Hampshire, who welcomed the Association and friends to the University. Professor George A. Perley showed laboratory model for a new sulphuric acid tower process and explained the same. Professor Melvin M. Smith called attention to research problems at the University after which the various laboratories were visited and the problems explained by the men in charge.

Mr. Charles H. Stone of the Boston English High School showed a number of lecture experiments designed to emphasize the general principles of chemistry. Mr. W. W. Obear of the Somerville, Mass., High School spoke on "What a Boy Likes" illustrating his talk with experiments to show how closely related chemistry is to everyday life.

After lunch the business meeting was held at which Mr. Wilhelm Segerblom of the Phillips Exeter Academy told of the Baltimore meeting of the American Chemical Society and urged those interested in the teaching of Chemistry to subscribe to the Journal of Chemical Education. The Secretary called attention to the summer session of the Massachusetts Institute of Technology from July 6th to 31st at which special courses in methods of teaching the Sciences and Mathematics are to be given for teachers.

Dr. Edward R. Berry of the Thomson Research Laboratory of the General Electric Company spoke on "Manufacture and Uses of Clear Fused Quartz" and illustrated his talk with many experiments and showed specimens.

In closing the University entertained the Association and friends with a baseball game between the University and Tufts College.

Respectfully submitted,
JOHN H. CARD,
Secretary to the N. E. A. C. T.

"Guidance conferences" for freshmen students at West Virginia University are proving to be of value and interest. Addresses adapted to the needs and problems of university men are given and the students invited to take an active part in discussions. "The choice of a life career," "Intelligence tests," and "How to study" are among the subjects presented by students for discussion.—*School Life.*

SOME CITIES PAY TEACHERS' SALARIES ALL THE YEAR.

Teachers' salaries are usually paid in 10 installments, and the teachers are expected to save enough during the school term to pay their expenses during the vacation. This usually involves no inconvenience, but occasionally instances of hardship have occurred as a result of the practice. An increasing number of cities have therefore adopted the plan of making salary payments monthly throughout the year. Among the large cities which pursue this plan are Boston, Denver, Los Angeles, Memphis, New York, San Antonio, Seattle, and Tacoma.

The University of Wisconsin

Summer Session

June 29 to August 7

Fee for All Courses, $22
(Except Law, $35)

Full program of courses in undergraduate and graduate mathematics and the natural sciences. Teachers' courses a specialty. Excellent library and laboratory equipment for research and higher degree work.

Northern Lakeside Advantages

For Full Information Address

Director Summer Session
Madison, Wis.

117.7 Per Cent Gain

If You Want Results, You Want

Thorndike Arithmetics

Texts Used Exclusively in Kansas City, Missouri, Since 1917

The Department of Research and Efficiency of the Kansas City Schools in its November, 1925, report, shows a gain over 1915 of *117.7* per cent in the ability of pupils to add, subtract, multiply, and divide, as determined by scientific tests in examples correctly solved.

The ***Thorndike Arithmetics*** are a course of study in themselves.

Followed page by page, they give the easiest mastery of the fundamental operations.

RAND McNALLY & CO.

New York CHICAGO San Francisco

Dept. F-173

REVIEW QUESTIONS

Twelve Thousand Questions in Eighteen Booklets

Algebra	Plane Geometry
Chemistry	Solid Geometry
Physics	Trigonometry

Six Pamphlets by Franklin T. Jones

French Grammar Review—American History and Civics—Ancient History

Three Pamphlets just published—compiled by Expert Teachers

Other Pamphlets

French A, French B; German A, German B; First Latin, Second Latin; Medieval and Modern European History (including English History); Question Book on History; English.

Price, each pamphlet, 50c. except English, Second Latin and French Grammar Review, 60c. Sample copy to a teacher half-price when money is sent with the order.

Liberal discounts for Class Use

Published and for Sale by

THE UNIVERSITY SUPPLY & BOOK CO.

10109 Wilbur Ave., Cleveland, Ohio.

MISSING CHEMICAL ELEMENT LOCATED BY ONE FAINT CLEW.

Element 61, one of the five missing chemical building blocks of all matter, may soon be revealed to the world.

Prof. C. J. Lapp of the University of Iowa told the American Physical Society meeting at Ann Arbor, Michigan, of his systematic search for this elusive element, which, though not heretofore detected by chemical or physical means, has had many of its properties predicted. Element 61 is known to be a rare earth, in the same class with cerium, whose oxides are used in the manufacture of gas mantles. There is a vacant space in the periodic table of chemical elements between number 60, neodymium, and 62, samarium, waiting to be filled.

One faint clew to missing element 61 has been found by Prof. Lapp. By examining some samples of rare earths carefully prepared by his colleague, B. S. Hopkins, he has discovered a single and very faint line in the spectrum produced by X-rays reflected onto a photographic plate from the rare earth sample. This line is not claimed by any other chemical element and corresponds very closely in wave-length to a line predicted on theoretical considerations as belonging to element 61. On this evidence Prof. Lapp believes it likely that element 61 is present in his samples of rare earths in quantities of about 1 part in 2000 or less.

Even if later research results in the definite identification of element 61 and its chemical isolation, it is doubtful if it will be of any commercial value. Very few of the rare earths are utilized in everyday life and they are usually so mixed up one with the other that they are only occasionally separated with any degree of purity. The rare earths include such unfamiliar elements as: serium, praesodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium, holimium, erbium, thulium, ytterbium, cassiopeium.

There are now only five missing chemical elements, including number 61. All the rest of the 92 elements, from the lightest, hydrogen, to the heaviest, uranium, have been discovered. Numbers 43, 75, 85, and 87 are among the missing.

Many of the chemical elements have been first discovered in the spectrum and then found and isolated by chemical means. Helium was discovered in the sun in 1868 by lines seen in the spectrum of sunlight and not until 1895 was it isolated by Sir William Ramsay. The latest conquest of physics and chemistry was the discovery of element 72, hafnium, by the Dutch physicist Coster and the Hungarian chemist Hevesy working in the laboratory of Prof. Niels Bohr in Copenhagen. Using first the X-ray spectroscope and then chemical methods, they discovered that hafnium frequently occurs in zirconium minerals and makes up about one two-hundred-thousandths of the earth's crust. It is more plentiful than the well known metal, Tungsten. The periodic table of elements, devised by the Russian chemist, Mendeleeff in 1869, arranged the elements in logical order and allowed prediction of some of those then missing. Moseley, the young British physicist who was killed early in the World War, was able by applying X-ray spectroscopic methods to arrange the known chemical elements in an orderly series according to their atmoric numbers. This classification is more enlightening than the Mendeleeff periodic table and has allowed more precise prediction of the properties of missing elements.—*Science Service.*

LEITZ

Binocular Stereo Magnifiers

Large Field, Stereoscopic Vision, Long Working Distance

Model "BSM-F," No. 22146.

Model "BSM-F"

Adapted in an ideal manner for use in

ANATOMY
BOTANY
EMBRYOLOGY
HISTOLOGY
ZOOLOGY
AND
ALLIED
STUDIES

Interchangeable eyepieces offer a variety of magnifications.

Prism body can be used on any one of a variety of ten (10) stands to fit each individual need.

(*Write for Pamphlet No. SS 1060*)

LEITZ-QUALITY OF OPTICAL AND MECHANICAL WORKMANSHIP

E. LEITZ INC. NEW YORK
60 EAST 10TH ST.

LEITZ-QUALITY IS NOT SURPASSED OR EQUALLED IT IS SUPREME

AGENTS:

Pacific Coast States—Spindler & Sauppe, 86 Third St., San Francisco, Cal.
Canada—The J. F. Hartz Co., Ltd., Toronto, Canada.
Philippine Islands—Botica de Santa Cruz, Manila, P. I.
Cuba—Texidor Co., Ltd., Havana, Cuba.

SCIENCE QUESTIONS.

Conducted by Franklin T. Jones.

The White Motor Company, Cleveland, Ohio.

To Readers of School Science and Mathematics:

You are invited to propose questions for solution or discussion.

You are asked to answer questions.

Examination papers are always desired. Send in your own papers or any others. Some are interested in college entrance examinations, others in school or college examinations. All are desired.

Please address all communications to Franklin T. Jones, 10109 Wilbur Avenue, S. E., Cleveland, Ohio.

EXAMINATION PAPERS

At this season of the year it is always interesting to see what someone else has done in the matter of examinations. The following papers will be suggestive. They are:

Physics. September, 1924. Massachusetts Institute of Technology.

Chemistry. Mid Year, 1925. Bernardsville, N. J.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

PHYSICS.

September, 1924

470. **Answer any eight questions.**

Time—Two hours. Candidate Number————

1. A hollow sphere of glass weighs 500 grams in air and requires a downward push of 1,000 grams to hold it under water. The density of the glass is 2.5 grams per cubic centimeter; what is the volume of the space inside of the glass sphere?
2. A rifle weighing 8.7 pounds shoots a 0.32 ounce bullet at a velocity of 2,700 feet per second. (*a*) What is the kinetic energy of the bullet? (*b*) With what velocity does the rifle recoil?
3. A horse exerts a pull of 68¾ pounds on a plow and draws the plow along at a velocity of 4 feet per second. Find the work done by the horse in one minute and find the horse power developed by the horse. Reduce the result to watts.
4. A 20-pound weight is suspended from the middle of a cord 10 feet long, the ends of the cord being fastened to points 8 feet apart on the ceiling. What is the tension of the cord?
5. One gram of alcohol gives 7,200 calories when burned. What is the efficiency of a stove which burns 15 grams of alcohol per minute and changes 4 kilograms of ice at 0° C. to water at 100° C. in 16 minutes? The latent heat of fusion of ice is 80 calories per gram.
6. An electric heater takes 5 amperes from 110-volt supply mains. (*a*) How long would it take for the heater to develop 1,000,000 calories? (*b*) How much would the 1,000,000 calories cost at 10 cents per kilowatt-hour? (*c*) The resistor in the heater consists of two exactly similar wires connected in series. What is the resistance of each wire?
7. An electric motor takes current from 220-volt supply mains. The motor develops 3 horse power and its efficiency is 85 per cent. How much current does the motor take?
8. A double convex lens has a focal length of 8 inches. At what distance from the lens must an object be placed in order that the lens might form a real image of twice the length of the object?
9. A 16-candlepower lamp gives an intensity of illumination sufficient for easy reading when the lamp is 3 feet from the book page. At what distance would a 32-candlepower lamp give the same intensity of illumination?
10. Explain what is meant when it is stated "the index of refraction of

Two Outstanding Texts in Science for Secondary Schools

CHEMISTRY IN EVERYDAY LIFE
by
Emery-Davis-Downey-Boynton

PHYSICS IN EVERYDAY LIFE
by
William D. Henderson

CHEMISTRY

This very outstanding new text in chemistry has won for itself an immediate place with instructors. The general plan, procedure, organization of material, content, and illustration, are most excellent. The requirements of chemistry are presented in 393 pages; 267 pages of additional material in applied chemistry are offered in the last half of the book. The plates have been carefully revised for errata and the mechanical make-up is excellent.

This text costs the student $1.76. There is a complete loose-leaf manual to accompany.

PHYSICS

This excellent text has steadily increased in favor. The author is a past master in the subject, having established for himself a place as an educator and author.

This book is characterized by exceptional diction. Topics are presented in logical order. Development is inductive. Phenomena are emphasized. Exercises are carefully graded. While the material is delightful reading, the text is not untechnical. There is a total of 566 pages.

Cost to the student is $1.60. There is a loose-leaf manual to accompany.

LYONS AND CARNAHAN

Educational Publishers

CHICAGO NEW YORK

water is 1.33." Is the index of refraction the same for "red light" and for "blue light"?

---

471. Submitted by Waldo W. Spear, Bernardsville, N. J. January, 1925.

CHEMISTRY—MIDYEAR EXAM—BERNARDSVILLE, N. J.

Name_____

Answer the first seven questions *and three of remaining.*

1. Write equations for the following reactions. They must be balanced to receive full credit:—
   (*a*) sodium carbonate and nitric acid.....
   (*b*) hydrogen sulfide burned in an excess of O_2.....
   (*c*) aluminum hydroxide and sulfuric acid.....
   (*d*) sodium and water.....
   (*e*) lead nitrate and hydrochloric acid.....
2. Name the following:—
   $KClO_3$ Na_2SO_3 Mg_3N_2.....
   $Ca(ClO)_2$ Ag_2SO_4.....
   PbO $CuCl_2$ FeS.....
   NH_4NO_2 $Ba(ClO_2)_2$.....
3. Give formulas for:
   carbon monoxide sulfurtrioxide ozone.....
   salt sodium bisulfate hydrosulfuric acid.....
   ammonia nitric oxide hydrogen hydroxide.....
   calcium phosphate.....
4. How many grams of sulfur are present in 1 kg. of alum, $K_2SO_4Al_2(SO_4)_3\,24H_2O$, K = 39, S = 32, Al = 27, O = 16, H = 1. Ans.....
   (*b*) If 0.05 gr. of magnesium liberate 0.00413 gr. of Hydrogen from HCl, calculate the equivalent weight of magnesium. Ans.....
5. Find the formula of a gas one liter of which weighs 1.17 gr. at S. C. On analysis it contained 92.31% carbon and 7.69% hydrogen. C = 12, H = 1. Ans.....
   (*b*) How many gr. of zinc, reacting with dil H_2SO_4, are required to give 1 l. of hydrogen at O°C and 3040 mm. pressure? (Zm = 65; 22.4 l. of H_2 at S. C. weigh about 2 gr.) Ans.....
6. Give the test for a chloride, using equation.....
   .....
   .....
   (*b*) a sulfate.....
   .....
   (*c*) silver.....
   .....
   (*d*) carbonate.....
   .....
   (*e*) nitrate.....
   .....
7. Prove that the chlorine molecule contains at least two atoms.....
   .....
   .....
   .....
   .....
   (*b*) State any law or hypothesis.....
   .....
   State two uses for it.....
   .....
   .....
8. By means of a chart show all the derivatives (and uses for each) of either H_2SO_4 or HNO_3.

Kewaunee

Superior

Laboratory Furniture

Good Laboratory Furniture stimulates student interest and encourages better work. Instructors also are able to serve with greater efficiency. In thousands of universities, colleges, high schools, normal schools, vocational schools, medical colleges, private and industrial laboratories, Kewaunee Laboratory Furniture is contributing greatly to the convenience and success of the work. Our 18 years of experience and constant contact with laboratory problems has enabled us to assemble the best ideas for the Kewaunee Line.

Let Us Send You The Kewaunee Book

Contains 416 pages with 46 views of buildings and model installations. We show here just a few of the hundreds of items that will increase interest and efficiency in any Laboratory. The Kewaunee Book will be sent without charge, postpaid, to any instructor or official who replies, giving his position and using the stationery of the institution. Address all inquiries to the factory at Kewaunee.

Kewaunee Mfg. Co.
LABORATORY FURNITURE EXPERTS

C. G. CAMPBELL, Treas. and Gen Mgr.
114 Lincoln St., Kewaunee, Wis.
New York Office, 70 Fifth Avenue
Offices in Principal Cities

Chemical Table No. 850
Designed for use in the small school chemical laboratory. Eight students may be accommodated, working in sections of four.

Combination Physics and Chemistry Table No. 14223
This design is practical for use as a student's desk or in a private laboratory. Has two larger and eight smaller drawers and four cupboards. Very solidly constructed and finely finished.

Physics Laboratory Table No. 700
Very popular with teachers. Very substantially built. Can be supplied, if desired, with lower cupboard and drawers.

Chemical Desk No. 8020
This design contains two features not to be overlooked. The electric light attachments are new. The small drawers extending through the entire table provide storage room for long condensing tubes and other equipment. This desk will accommodate twenty-four students working in groups of eight.

9. Experiment: Title *Preparation and Properties of HCl*
Procedure:.....
.....
.....
.....
..... Diagram
.....
Procedure and Results to show properties: (*a*).....
.....
.....
.....
.....
.....
Conclusion:.....
10. Balance:
(*a*) Copper and nitric acid.....
(*b*) Silver and HCl.....
(*c*) Zinc and conc H_2SO_4 .....
(*d*) Zinc and dil H_2SO_4 .....
(*e*) Ammonium nitrite (heated).....
11. .....is a gas without color and odor. It is used to make carbonated water. It is..... soluble in water. As with all gases its solubility is greatly increased by increase in..... It will not.....nor does it support..... When allowed to bubble through.....a white precipitate is formed. It can be reduced by heating it with..... The product of this reduction is..... This gas is.....active. The lab method of preparing this gas is to add ..... to..... The equation is:.....
12. Name three gases used in refrigeration plants.....
..... Diagram a refrigeration..... plant and explain how it operates. .....
.....
.....
.....
.....
(diagram)

SOLUTIONS AND ANSWERS.

461. *By courtesy of the Metric Association.*

METRIC CROSS WORD PUZZLE NO. 1.

Across

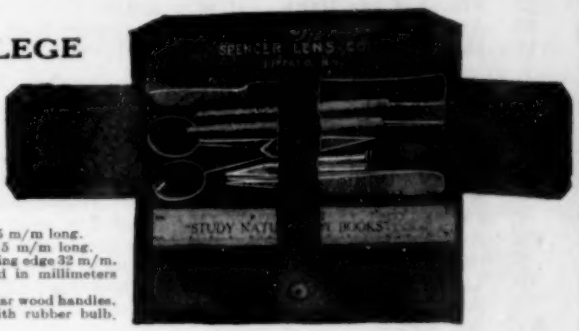
1. Plural of the unit of weight in the metric system.
6. Christmas pie.
11. Plural of the 1000th part of a meter.
13. What we should do with the metric system.
14. A metal.
15. One who goes crazy to learn all our present antiquated hodgepodge of weights and measures.
16. First letters of the following groups favoring the general use of the metric system: Nurses, Engineers, Manufacturers, Scientists.
18. Prefix meaning 1000.
19. To draw off water or any liquid.
21. Abbreviation for the Biblical name Baalperazim.
22. Fundamental standard from which metric system is derived.
23. Popular science where wave lengths are given in meters.
26. Synonym for conversed in phonetic spelling.
30. Any defined extent of plane surface, as the space included in each of these square centimeters.
31. Abbreviation for gram.
32. Part of automobile on which dimensions are marked in millimeters.
33. Abbreviation for National Volunteers of America.
34. Number, the basis of the metric system.
36. Largest metric, equal to 100 kilograms.

AMERICAN HEADQUARTERS
DISSECTING INSTRUMENTS

FOR
SCHOOL and COLLEGE USE

Special Offer To Schools

Dissecting Set Number 3300



Consisting of:
1—No. 2030 forceps, 115 m/m long.
1—No. 2920 scissors, 115 m/m long.
1—No. 2410 scalpel, cutting edge 32 m/m.
1—No. 3100 ruler, ruled in millimeters and inches.
2—No. 2290 needles, cedar wood handles.
1—No. 6700 pipette, with rubber bulb.

PUT UP IN ONE FOLD LEATHERETTE CASE AS SHOWN

Per Set $1.57 Net

Discount on Quantities

GUARANTEE QUALITY **Catalog Sent on Request**

SPENCER BUFFALO U.S.A.

SPENCER LENS CO.
Manufacturers
Microscopes, Microtomes, Delineascopes, Optical Measuring Instruments, Etc.
BUFFALO, N. Y.

SPENCER BUFFALO U.S.A.

WIESE
FURNITURE
Appreciated Wherever Installed

Praise invariably follows Wiese installations. Such letters as this one from Geo. F. Hale, Supervisor of Educational equipment, Minneapolis, Minn., are the rule, not the exception:

"It is a pleasure to state that our Bureau of Buildings, especially our Equipment Division, *appreciates* both the *excellent quality of workmanship and materials* evident in the goods you have furnished us, *and the high standard of services rendered in deliveries and installation.*"

An extra measure of service . . . this is the Wiese rule.

Ask for our new catalog No. 24

WEISE LABORATORY FURNITURE CO.

For 28 years, makers of Standard and Built-to-order Educational and Technical Furniture for Physics, Chemistry, Agriculture, Biology, Household Economics, and Manual Training.

FACTORY: MANITOWOC, WIS.
Sales Offices in Principal Cities.

37. Plural of the 100th part of a meter.
40. An old yarn measure about 500 meters long.
41. Bad in a greater degree.

Down.

1. Town in Wurtemburg, Germany.
2. One who gets up.
3. Name of a town in ancient Gilead.
4. Abbreviation for milliliter.
5. To take a seat.
6. A primate mammal whose average weight is 70 kilograms.
7. Pronoun.
8. An elegy.
9. Old word meaning curly.
10. Legal term meaning to impede or bar.
12. Article worn by baseball catcher.
17. An ape.
18. Weight, two-tenths of a gram, used by jewelers in weighing precious stones.
20. Prefix meaning "new."
21. Wager.
23. Cattle-farm.
24. District in India.
25. American diplomat who died in 1789, about the time the metric system was formulated.
27. The metric unit of capacity for both liquid and dry measure.
28. A jumble of letters as unrelated as the old weights and measures being replaced by the metric system.
29. Rigid.
31. Precious stone.
34. Abbreviation for "it is."
35. The kind of idea worth investigating.
38. The initials of a famous man who said of the metric system: "We must have it."
39. Preposition.

Solution by Ethel M. Smalley, Student in Freshman Class, High School, Pomeroy, Ohio.

1 G 2 R A 3 M 4 S 5 6 M I 7 N 8 G 9 E 10
11 M I L L 12 M E T E R S
13 L S E 14 T I N 15 N U T
16 N E M 17 S T 18 K I L O
19 D R A I 20 N 21 B A A L P
22 M E T E R
23 R A 24 D I O 25 26 T A L 27 K 28 29 T
30 A R E A 31 G 32 I R E
33 N V A 34 T E N 35 36 T O N
37 C E N T I M E S 38 T E 39 R S
40 H E E R S 41 W O R S E

Books for Summer Use

OUR PHYSICAL WORLD

By Elliot R. Downing

In this scientific age there is no better way to initiate the child into the mysteries of earth, air, and water than through the mechanical toys he plays with. This source book provides the teacher and parent the subject-matter of physical science organized about toys and familiar home appliances. From Mr. Downing's directions, the construction of a homemade orchestra or a radio is equally easy. The book is a step toward a more efficient organization of modern science study.

Cloth $2.50, flexible binding $3.50
Postage 10 cents extra

OUR LIVING WORLD

By Elliot R. Downing

Simple, non-technical, and vivid in its description of common plants and animals, this book will help its readers to develop a familiarity with living things. It has been organized with special reference to the training of the teacher and the presentation of the subject to the pupil. For every reader it is a revelation of the marvels of the commonplace.

Cloth $2.50, flexible binding $3.50
Postage 10 cents extra

STATISTICAL TABLES FOR STUDENTS IN EDUCATION AND PSYCHOLOGY

By Karl J. Holzinger

Most handbooks of calculating tables are too elaborate to be of any great use to beginning students in educational or psychological statistics. As a specific remedy for this state of things, Mr. Holzinger has prepared this manual. It greatly simplifies calculation in averages, dispersion, correlation, and uses of a normal curve. There are tables for logarithmic calculations, square roots, quotients and products, and a list of useful constants with values and logarithms.

$1.50, postpaid $1.60

How to Study

By A. W. Kornhauser

Good study habits never cease to be useful, and he is fortunate who learns an effective method at the outset. In this little pamphlet of only forty-two pages is the key to making the most of study hours; it is a practical handbook for everyone. Mr. Kornhauser is a psychologist and has formulated rules for memory and concentration that are psychologically sound. His is a complete manual for the improvement of study techniques—how to banish distraction; to budget one's time; to read effectively, intensively, and rapidly; to take notes; and to review.

25 cents, postpaid 27 cents

How to Study Modern Languages in College

By Peter Hagboldt

The student of modern languages could be assigned no more profitable first lesson than the contents of this small handbook. It outlines a definite study technique for studying modern languages, and discusses aims and methods of modern language study. Mr. Hagboldt gives fundamental rules for studying grammar, pronunciation, vocabulary, reading, and translation.

25 cents, postpaid 27 cents

¶ *Before you start your travels this summer read "Meek Americans" by Joseph Warren Beach, "a delightful collection of informal essays . . . . for the corner of a bag packed for Europe" (New York Post). $2.00, postpaid $2.10.*

THE UNIVERSITY *of* CHICAGO PRESS

5841 ELLIS AVENUE CHICAGO, ILLINOIS

Please mention School Science and Mathematics when answering Advertisements.

BOOKS RECEIVED.

The Early Embryology of the Chick by Bradley M. Patten, Western Reserve University. Pages ix+177. 16x24 cm. Cloth. 1925. $2.25. P. Blakiston's Son & Co., Philadelphia.

Common School Text Books by Ginn & Company. Pages x+77. 13x19 cm. 1925. Paper. Ginn & Company, Boston.

New Frist Course in Algebra, by Herbert E. Howker. Columbia University, William A. Laby, Junior College of Kansas City and Frank C. Touton. University of Southern California, pages IX+361, 13.5x19 cm. Cloth, 1925. $1.24. Ennis & Co., Boston.

Essentials of Algebra, by Davis E. Smith, and William D. Reeve. Columbia University. Pages viii+274. 13.5x19 cm. Cloth, 1925. $1.24, Ginn & Co., Boston.

Plane and Spherical Trigonometry by Murray J. Leventhal. University of the State of New York. Pages iii+58, 13x19 cm. Paper, 1925. Globe Book Co., 176 Fifth Ave., New York.

Analytic Geometry and Calculus by Bolling H. Crenshaw and Cincinnatus D. Killebrew. Alabama Polytechnic Institute. Pages x+222. 16x23.5 cm. Cloth, 1925. $2.75.

Open Doors of Science by Otis W. Caldwell, Lincoln School, Columbia University, and W. H. D. Meier, Normal School, Framingham, Mass. Pages x+333. 13x19 cm. Cloth, 1925. 96 cents. Ginn & Co., Boston.

A Laboratory Manual of Experiments in Physics, by Leonard R. Ingersoll. University of Wisconsin. Pages ix+220. 14.5x21 cm. Cloth, 1925. $2.00. McGraw-Hill Book Co., 370 Seventh Ave., New York City.

New Essentials of Business Arithmetic and New Complete Arithmetic by George H. Van Tayl. Evander Child's High School, New York City. Pages 302+xu. 14x20.5 cm. Cloth, 1925. and 440+xxiv. 14x20.5 cm. Cloth, 1925. American Book Co., New York City.

The Early Embryology of the Chick by Bradley M. Patten. Western Reserve University. Pages xi+177. 16x24 cm. Cloth, 1925. $2.25. P. Blakiston's, Son & Co., Philadelphia, Pa.

BOOK REVIEWS.

Biology and Human Life, by Benjamin C. Gruenberg, formerly Head of the Biology Department in the Julia Richman High School, New York. pp. xiv +592. 1925. $1.72. Ginn and Company, 15 Ashburton Place, Boston.

The general plan and organization of this new biology text have been worked out along unique and original lines. The different chapters of the book begin with a series of questions which serve to give a general view of the new subject. At the end of each chapter there is an outline which gives the proper relation of the different facts brought out or suggested. Then, there follows a list of teacher-questions which should tie together, unify, the different points brought out in the discussion of the subject. A list indicating reference readings is appended to each chapter.

Part I is headed, "Getting Aequainted with Life." 91 pages are devoted to general considerations of animals and plants as living things. Part II, "The Biology of Health," takes up problems of keeping the body in condition, the control of the body and the control of the environment for health, devoting 305 pages of text to health instruction, directly. The special economic phases are dealt with in Part III, "The Biology of Wealth." 174 pages are used in the discussion of the problems concerning production and conservation.

The book is thoroughly modern in point of view and selection and

PASTOR STOP WATCH

American-Made Timepiece

Price, $7.50

Fills a long felt want. Robust and satisfactory for laboratory use. Regular size with nickel plated finish and unbreakable bezel. Hour, minute and second hands as in ordinary watches. Also has sweep hand and push pin.

Outer circle of dial graduated to fifth seconds, or, if preferred, to hundredths of a minute subdivided in one-half.

Write for Bulletin No. 352 Which Gives Additional Details

EIMER & AMEND

Est. 1851 Inc. 1897

HEADQUARTERS FOR LABORATORY APPARATUS AND CHEMICAL REAGENTS

NEW YORK, N. Y.
Third Ave., 18th to 19th St.
Pittsburgh, Pa., Agent, 4048 Franklin Rd., N. S.

HARVARD UNIVERSITY
SUMMER SCHOOL
of Arts and Sciences and of Education
July 6 to August 15, 1925

Professor William L. Eikenberry, Head of the Science Department, East Stroudsburg State Normal School, Pennsylvania, offers

Education SM7—The Teaching of General Science.
Education SM8—Biology in the Senior and Junior High School.

Assistant Professor Ralph Beatley, Harvard University, offers

Education SM1—The Teaching of Mathematics in the Senior High School and in the Four-Year High School.
Education SM2—The Teaching of Mathematics in the Junior High School.

For information in regard to other courses in Education and in the Arts and Sciences address:

THE SECRETARY OF THE SUMMER SCHOOL
Harvard University
CAMBRIDGE, MASSACHUSETTS

treatment of subject matter. It deals with biological principles rather than with plants and animals in particular, and the discussions throughout the book relate the various laws and principles to man's welfare. All secondary school biology teachers will want to see this book.

History of Mathematics by David Eugene Smith, LL. D., Professor of Mathematics, Teachers College, Columbia University. Volume II. Special Topics of Elementary Mathematics. Pages xii +725. 14 ×21 cm. $4.40. Ginn and Co., Boston, Mass.

This volume completes the work whose first volume has already been reviewed, (Vol. XXIV, May, 1924, p. 548). The general characteristics of the first volume are maintained in the second. There is the same fascinating and limpid style, the same unique combination of an enormous body of facts with a main text that is not overloaded with details, the same extremely suggestive lists of "Topics for discussion," an even greater wealth of helpful illustrations, (though no portraits are given in this volume), and an even more strikingly smooth and readable presentation which raises the work from a mere compendium of technical facts to a masterpiece of the literary art. To this the plan of the second volume contributes, which deals with the history of special topics and so lends itself more readily to a connected and homogeneous treatment.

The ten main topics cover the field of elementary mathematics from the beginnings of number to the first steps in the calculus; more advanced topics are, however, repeatedly taken up as subtopics. It is not necessary to list the topics here but is sufficient to repeat from the review already mentioned a statement that is now applicable to the work as a whole. Every student of mathematics should become acquainted with the work at first hand. In every library for English speaking users, high school, college or university, institutional or personal, this work should indubitably be the next on the hisory of mathematics to be acquired.

The two volumes are to be used together. In a sense, they cover the same ground, yet there is no mere repetition or needless duplication. There are separate indexes for the two volumes and both must be consulted if one wishes to find all that is given on any particular topic.

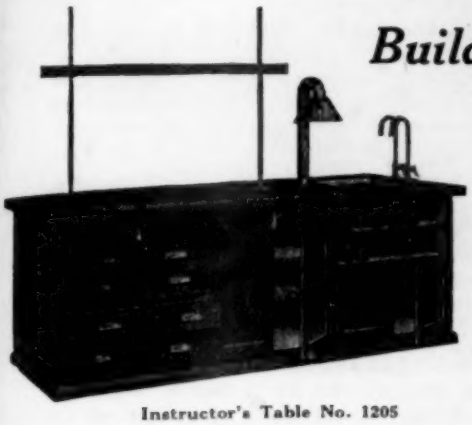
Taken as a whole the work gives a most vivid picture of "how the science has so adjusted itself to world needs as now to be a necessity for the average citizen instead of a mental luxury for the selected few." For all teachers of mathematics this is one of the most important and helpful publications of our day, and fifty and a hundred years from now, it will still be a constantly used authority in its field. J. W. A. Y.

Chemistry for Secondary Schools, by Ernest L. Dinsmore, Chairman of Chemistry Department, Boys' High School, Brooklyn, N. Y. 1st edition, pp. viii +574. 13 ×19 ×2.6 cm. Cloth, 1925. F. M. Ambrose Co., New York and Boston.

While the content and order of treatment of this new text show little deviation from the usual there are a number of innovations which are worthy of note. Recognizing the importance of several newer parts of chemistry the author has given condensed accounts of the essentials of colloid chemistry, of radioactivity and of the newer concept of the sub structure of the atom. The elementary discussion of organic chemistry is made to follow the chapter on carbon since organic chemistry is essentially a study of the compounds of carbon.

The chapter on the Electrolytic Dissociation Theory is well done. We note the expression "Since acetic acid is a weak acid (226) it does not dissociate to any great extent even when a large amount of water is used" (p. 204). On page 206 the expression "The base, ammonium hydroxide, NH_4OH, does not yield many ions in solution. Hence it is

PETERSON LABORATORY FURNITURE



Instructor's Table No. 1205

Building to an Ideal

The entire Peterson Organization is instilled with one thought—"We are building to an ideal." Every piece of Peterson Furniture must bear rigid inspection and carry the mark of excellence.

If we could take you through our factory and show you the infinite care with which every process of manufacture is performed, you would appreciate the reasons why Peterson Equipment is so dependable—it is built to an ideal.

Send for Catalog No. 14

LEONARD PETERSON & CO., INC.

Manufacturers of Guaranteed Laboratory Furniture

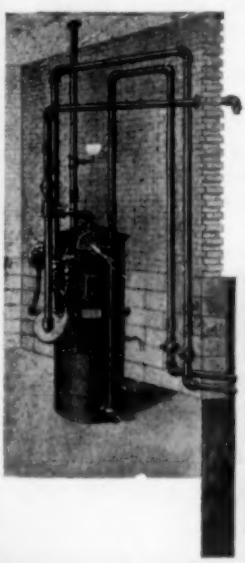
OFFICE AND FACTORY

1222-34 Fullerton Avenue — Chicago, Ill.

New York Sales Office: Knickerbocker Bldg., 42nd and Broadway

Back numbers of School Science, School Mathematics, and School Science and Mathematics may be held for 35 cents a single. The Mathematical Supplements for 20 cents a copy. In sets, the prices are, postpaid:

School Mathematics and Supplements, Vol. I, five numbers	$1.10
School Science, Vol. I, seven numbers	5.75
School Science, Vols. II, 7 numbers	5.00
School Science, Vol. 3, eight numbers	5.50
School Science, Vol. IV, three numbers	.85
School Science and Mathematics, Vols. V, VI, VII, VIII, IX, X, XI, XII, XIII, XIV, XV, XVI and XVII, each	2.75
School Science and Mathematics, Vols. XVII, XIX, XX, XXI, XXII, XXIII and XXIV, each	2.75



ELECTRICALLY OPERATED AUTOMATIC GAS MACHINE

Requires No Attention

Write to us for list of colleges and high schools using our machine. Illustrated Catalogue Will Be Sent on Request.

MATTHEWS GAS MACHINE CO.

6 E. Lake Street — CHICAGO, ILL.

This Machine Will *Automatically* Produce

GAS

For your laboratories and Domestic Science Department.

In use in hundreds of educational institutions throughout the country.

a weak base," shows that the author has the right idea in regard to the matter.

The book is adequately illustrated, it has an excellent appendix with some unusual tables, such as a table of tests for a number of metal ions and acid radicles. High School Chemistry teachers will want to examine it.

F. B. W.

Notes on Blow Pipe Analysis, by Nicholas Knight, Professor of Chemistry, Cornell College. 11th edition. pp. 19. 14 ×16.5 cm. Paper, 1925. Published at Cornell College, Mount Vernon, Iowa.

A telegraphic outline of blowpipe methods for those metals that are readily detected in this way and for those acid radicals that may be detected by heating in closed tubes. Wet tests for acid radicals are also given.

An excellent little outline. F. B. W.

Statistical Method in Educational Measurement, by Arthur S. Otis. pp. xi +337, 14 ×20 cm. Price $0.00. World Book Co., Yonkers on the Hudson, New York.

"In reality, this book does not deal with statistics as such. It deals with the method of interpreting statistics—one's own interesting data collected painstakingly for an important purpose." This view-point is adhered to throughout the book. Each new topic is introduced and developed by means of data which have been, or might have been, collected by a teacher or student; the practical aspect is never lost sight of; and each topic is followed by practice material. Several appendices provide extra practice material, tables to facilitate calculations, and a bibliography.

Dr. Otis emphasizes the construction and interpretation of the percentile curve, which, because of its simplicity and flexibility is rapidly coming into more general use. The meaning of correlation and its calculation is also thoroughly treated. The closing chapter points out how mental and achievement tests may be used in classifying students for more efficient instruction.

This book will undoubtedly find large use as a text book in Normal schools and colleges, but, further than that, it will appeal to any teacher who is interested in understanding the testing movement and wishes to apply its methods to her own problems. W. H. Spurgin.

Laboratory Manual of Experiments and Physics by Leonard R. Ingersoll University of Wisconsin. Pages ix+220. 14.50x21 cm. Cloth, 1925. $2.00. McGraw Hill Book Company, 370 7th Avenue, New York City.

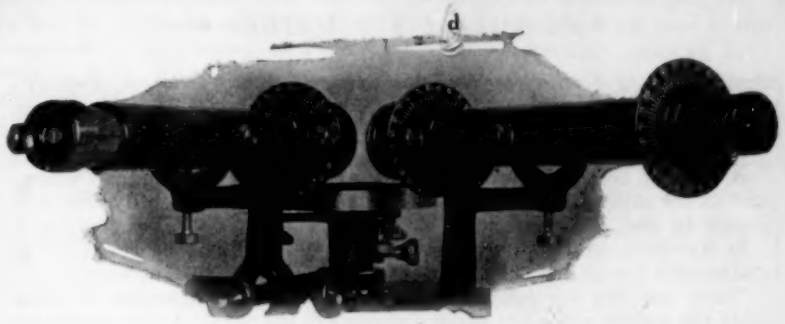
This manual is one which has been the outgrowth of laboratory work for many years in the University of Wisconsin. Although perhaps prepared more particularly for students of this university, it can be just as well used by any school of the same calibre.

It surely is a splendid book. The directions are clearly written and each student should be able to carry out the experiments without very much assistance from the instructor.

There are 56 well executed drawings made especially for this text. There are 76 experiments which have been well selected. Nearly every experiment closes with questions appertaining to that particular test.

The book is printed in ten-point type, has a table of logarithms, natural sines and tangents appended. It is well indexed, well made and worthy of being placed in any collegiate physics laboratory in the country.

C. H. S.



SIMPLE POLARIZING ATTACHMENTS

For Gaertner College Spectrometer

Recommended for studying Fresnel's laws of refraction, elliptical polarization by reflection and by transmission through crystals, etc. The attachment is made to fit our L 101 Spectrometer, but it can be fitted to any other small spectrometer at a nominal additional cost.

Two circles carrying rotable 10 mm nicols fit over the telescope and collimator objectives. A third circle at the eye end fits in the place of the usual adapter with cross hairs and carries a special Ramsden eyepiece with a nicol between the lenses. The circles are divided to 5 degrees and permit estimating to single degrees. The nicols may be rotated independently of the circle for adjustment of zero.

L 101d. Polarizing Attachments for L 101 Spectrometer, $60.00

Bulletin No. 101 on Spectrometers and Accessories will be mailed on request.

PHYSICAL APPARATUS

For Elementary Laboratory Work

Designed for Use with the Millikan, Gale and Bishop Course

GAERTNER APPARATUS for this course has been recognized as superior ever since its introduction. Many pieces of the apparatus were designed, in conjunction with the authors, by our President, Mr. Wm. Gaertner, himself an expert scientific instrument maker of world-wide repute.

Write for Catalog H-D:1923

The Gaertner Scientific Corporation

Successor to Wm. Gaertner & Co.

1201 Wrightwood Avenue **Chicago, U. S. A.**

Open Doors to Science, by Otis W. Caldwell, Lincoln School, Teacher's College, Columbia University, New York City, and W. H. D. Meier, Normal School, Birmingham, Massachusetts. Pages x+333. 13.50x19 cm. Cloth, 1925. $0.96. Ginn & Co., Boston, Massachusetts.

A pioneer book for pupils in the upper grades of grammar schools and at the same time a book that can be profitably studied by first year pupils in the High School.

It has been prepared by two past masters of Science study. The statements herein made are correct, and may be relied upon.

There are 204 carefully prepared half-tones and drawings to illustrate the points which are being discussed in the text. At the beginning of each chapter a set of questions is presented which lead up to the subject matter that is presented in that chapter. By no means is the list complete, but gives the reader an idea of what he may expect.

The writer wishes to congratulate the authors on preparing such a splendid book. It is printed in ten-point type on a good quality of paper. The diction is splendid and is so enchanting that when a pupil begins to read, he will become so interested that he will want to read it at a sitting. Major paragraphs begin with bold faced type which indicates the matter discussed in that particular paragraph. No better selection for seventh and eighth graders in Science can be made.

School boards will make no mistake in putting this book on their list.

C. H. S.

The Author's Book by The MacMillan Company. Pages xiv+73. 15.50 x22.50 cm. Paper, 1925. The MacMillan Company, New York City.

The publishers of this book are to be congratulated on bringing from their presses a book of this character.

It goes into considerable detail in telling Authors how to prepare their manuscripts. Also, it gives splendid directions on the reading of proof, and how Authors should deal with the publishers. In fact, all of the terms used in the publishing house, methods of reading proof, are splendidly described.

No person preparing a book, or who writes for magazines, should be without the splendid directions.

Authors! send for this book. C. H. S.

Laboratory Manual of Electrical Science by Ralph O. Buck and H. E. Frost, Lane Technical High School, Chicago. 160 Pages. 21x27 cm. Paper, 1925. $1.44.

This is a loose-leaf Electrical Laboratory Manual consisting of fifty experiments. It explains in simple and concise manner the principles of electricity, from magnetism to alternating currents.

The drawings have been carefully made, showing the exact methods of setting up the apparatus. No better manual can be found for secondary school work in electricity than the one that the writer is attempting to review.

It has been prepared in such a way that a pupil will be obliged to think and rely upon himself in order to successfully perform the experiments.

No electrical laboratory will make a mistake in selecting this book for its use. C. H. S.

Up to the minute SCIENCE and MATHEMATICS Teachers will not leave any stones unturned until they have discovered all the new and best methods of presenting to their pupils these particular topics of instructions.

SCHOOL SCIENCE AND Mathematics is the best anti-toxin to prevent sluggishness in teaching.

CONTENTS *for* OCTOBER, 1925

FROM THE LIBRARY OF HORATIO CHUTE

No Numbers Published for
JULY, AUGUST AND SEPTEMBER

Report of an Experiment in Correlated Mathematics in a Large High School—Paul R. Pierce 681
Air is Blue, Physicist Discovers—Science Service 684
Bird Study in High School Biology—Jerome Isenbarger 685
Lincoln School Laboratories 687
A Year in Biology I—Harry A. Cunningham 688
The Ballistic Pendulum; A Simple Apparatus for Studying Momentum and Energy Relations—Paul E. Klopsteg 694
Correlation in Non-Linear Types—William R. Ransom 700
Relative Value of Different Types of Questions in Reading Tests—Sterling G. Binkley 703
Real Estate Practice to Become an Exact Science—School Life 708
Apparatus for Demonstrating the Hydraulic Press—Harold H. Metcalf 709
Good Health Necessary to Proper Education—School Life 710
The Character of Laboratory Work for Students of Elementary Chemistry—W. G. Bowers 711
Science Clubs in the High School—Guy M. Smith 720
The Articulation of General Science with the Special Sciences—W. R. Leker 724
Mistaken Notions of Scientific Phenomena as They Now Exist Among Average Citizens—Clarence Bonnell 737
A Device for Teachers of Trigonometry—Norman Anning 739
Surgeon Cuts With Electric Needle—Science Service 741
A Natural Explanation—Science Service 741
Report of the Second Annual Chemistry Week at Rhode Island State College, Kingston—Joseph W. Ince 743
John M. Coulter 745
Southern California Science and Mathematics Association 745
Old "Ironsides" Campaign 745
The Local Study of Geography—Ella B. Knight 746
Extinct Volcano on Alaska Peninsula—Science Service 747
Missing Chemical Element Located by One Faint Clue—Science Service 748
Making the Laboratory the Basis of High School Science—H. H. Radcliffe 749
Books Received 753
Division of Chemical Education 754
Problem Department—C. N. Mills 755
November, 1925 Meeting of the Central Association of Science and Mathematics Teachers—Elliot R. Downing 756
Science Questions—Franklin T. Jones 760
Personals 770
Note on Removing Carbon From Test Tubes—Eaton V. Miller 770
Articles in Current Periodicals 774
Book Reviews 776

Trade with our Advertisers. They will deal squarely with you.

School Science and Mathematics

Member of the Educational Press Association of America

No Numbers Published for JULY, AUGUST and SEPTEMBER.

PRICE. The subscription price is Two Dollars and Fifty Cents a year, if paid in advance; at the rate 35 cents a copy for less than a half year; single copies 35 cents.

ALL REMITTANCES should be made payable to the order of **School Science and Mathematics. Remittances should be made by Post Office Money Order, Express Order, or Bank Draft.** If personal checks are sent, please add ten cents for collection.

SCHOOL SCIENCE AND MATHEMATICS is the "official organ" of the following associations: The Central Association of Science and Mathematics Teachers, Eastern Association of Physics Teachers, The Physics Club of New York, Missouri Society of Teachers of Mathematics and Science, Science and Mathematics Section of the Oregon State Teachers Association, Saskatchewan Science and Mathematics Teachers Association, Southern Pacific Science and Mathematics Teachers Association, Kansas Association of Mathematics Teachers, New York State Science Teachers Association, New Jersey Science Teachers Association, New England Chemistry Teachers Association, Langley Association of Science Teachers.

POSTAGE IS PREPAID for all subscriptions in the United States and Mexico. For Canada add 25 cents for postage. For all other countries in the Postal Union, add 50 cents.

CHANGE OF ADDRESS. Subscribers should send notice of any change of address before the 12th of each month; otherwise they are held responsible for magazine, sent to their former address, and no duplicate copies will be sent except on payment of 30 cents for each copy. Send notices to School Science and Mathematics, Mount Morris, Ill., or 2055 East 72nd Place, Chicago.

MANUSCRIPTS. Contributions on Science and Mathematics Teaching are invited. Articles must be written on one side of the sheet only. All illustrations must be drawn or written in jet black on a separate sheet of manuscript. Contributors are requested to write scientific and proper names with particular care. Manuscripts should be sent to the Editor of **School Science and Mathematics, 5517 Cornell Ave., Chicago,** or to the proper departmental Editor. Books and pamphlets for review should be sent to the Editor. To insure insertion in any number, manuscript must be in the editor's *possession not later than the 20th of the second month before* publication.

MISSING NUMBERS will be replaced *free* only when claim is made within thirty days after receipt of the number following.

REPRINTS, if desired, must be ordered in advance of publication. Reprints of leading articles will be printed as ordered, the actual cost (with cover, if desired) to be paid for by the author. Reprints *must* be *paid* for when ordered. The table below shows the *approximate* cost of reprints consisting of plain text or text with line engravings. The actual cost may vary from the figures given and will depend upon the amount of work in re-making the pages into forms, press work, paper, printing, etc.

Number of Copies	100	Extra Hundreds	Number of Copies	100	Extra Hundred
2 pages	$1.65	$0.30	16 pages	$7.35	$1.50
4 pages	2.30	.50	20 pages	9.60	1.75
8 pages	4.75	.90	Cover, extra	3.10	.50
12 pages	6.75	1.35			

SCHOOL SCIENCE AND MATHEMATICS

PUBLICATION OFFICE **MOUNT MORRIS, ILLINOIS**

Business Office, 2055 72nd Place, Chicago

Editorial Office, 5517 Cornell Ave., Chicago

Please mention School Science and Mathematics when answering Advertisements